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December, 1961

INDUSTRIAL QUALITY CONTROL

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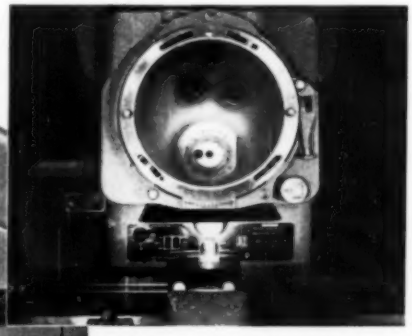

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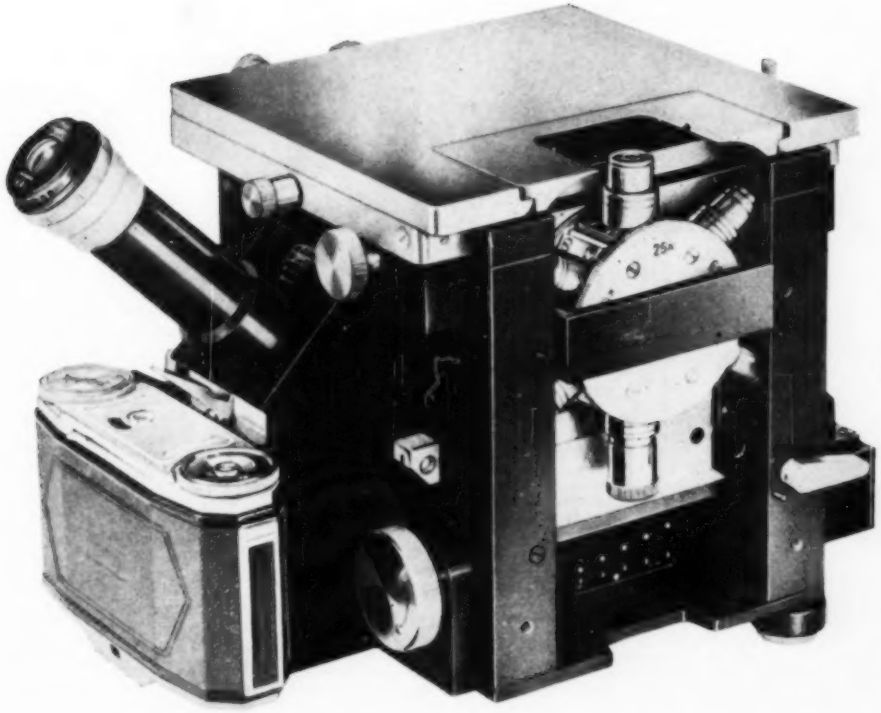

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Controlling Quality in the Production-Engineering Climate

Part II

J. BRAVERMAN

Frankford Arsenal, Philadelphia, Pa.

> ***Editorial Note***
> *This is the final part of this article. Part I appeared in the November, 1961 issue.*

Stage II—Initial Production Run

The Initial Production Run Stage represents that portion of the manufacturing cycle up to approximately ten to 25 percent completion of the order. Here is where the effects of the method, man, material and facilities upon the quality, quantity, and economic requirements are closely scrutinized, and altered where necessary. It is at this stage that the effects must be particularly compatible with the requirements, for what follows is only as good as what has been initially established. Economically the costs of detection and prevention in this stage are only a fraction of the magnitude that the costs would reach if the undesirable effects were permitted to carry over to Stage III, the Regular Production Stage. The quality control activities in Stage II are described below.

Product & Process Quality Reporting Method

Since the ultimate measure of quality in process is the actual evidence of product yield and mortality, provisions must be made for maintaining and presenting the "quality score." How should the data be collected, analyzed, and presented? How frequently should reports be issued? How sensitive should they be? These questions, which are usually unique to the production-engineering type of job, confront our quality control activity.

An effective system of reporting is described below:

a. Six copies of the Inspection Report (Fig. 7) covering types of components and assemblies at all stages of product growth are distributed to manufacturing supervision, methods engineering, production control, cost control, quality control and process inspection.

b. Data from the Inspection Report is collated, analyzed, and fed-back by quality control in the following manner:

(1) *Weekly Quality Summary Report* — describes percent defective rates on a weekly and to-date basis.

(2) *Weekly Report of Leading Defects* — points out leading defects and trends.

(3) *Monthly Product and Process Quality Reports* —graphically depicts, on a percent defective basis, the total mortality, scrap and rework (on a monthly and cumulative basis) charged to the appropriate manufacturing shop. Monthly control limits $p' + 2\sigma$ are incorporated in this report (Fig. 8) so that performance can be compared to a standard. Out-of-control conditions are associated with the leading defect(s) so that corrective action can be directed most effectively.

c. The First-Piece or Layout Inspection Report is used to record results of first-piece inspection during processing, or layout inspection on new or modified foundry castings. Notice in Fig. 9 that first piece inspection is only performed in limited cases.

d. The Frequency Distribution Report is used when inspection data are in variables (Fig. 10). This report can be attached to the Inspection Report or to any other report of product or process quality which is fed back to methods or design engineers. Analysis of the frequency distribution is done by quality control. We look upon the frequency distribution as a tool, as well as a concept. This is an effective way to condense and summarize continuous data that permits the

INSPECTION REPORT

TO FOREMAN, MACHINE SHOP #2 FROM PROCESS INSPECTION

DRAWING NO.	REV	LOT NO.	WORK PRODUCED IN SHOP	WORK PRODUCED IN OPERATIONS
B-7598011	0	1	0556	5, 10, +15

NOMENCLATURE	WORK ORDER NO.	END ITEM	TIME & DATE STARTED
STUD	06414-01	NIKE-AJAX	9:00AM; 2/9/61

TYPE OF INSPECTION: LOT — DEFECTS BROUGHT IN:

SAMPLED	MAJOR	MINOR	SCREENED	MAJOR	MINOR	TOTAL	
A.Q.L.	1.5%		QTY. SCREENED	465		QTY. SUBMITTED	500
QTY. SAMPLED	35		QTY. ACCEPTED	251		QTY. ACCEPTED	271
QTY. DEFECTIVE	15		QTY. DEFECTIVE	214		QTY. DEFECTIVE	229

SUMMARY OF DEFECTS

TOTAL NUMBER OF PIECES	DEFECTIVE CHARACTERISTIC .250 ±.001 IN. .2518 to .2578	.250 ±.001 IN. .248 to .2487	.162 ±.002 IN. .158 to .157	.162 ±.002 IN. .1645 to .169
19	19			
8		8		
5			5	
14	14			14
189				189
CODED CHARACTERISTICS	C-25	C-24	C-26	C-25
CLASSIFICATION	M	M	M	M
DISPOSITION	Rwk	Scrap	Scrap	Rwk
CHARGE TO SHOP AND MACH GROUP	4	0556	→	

TIME & DATE FINISHED 2/9/61 3PM — INSPECTION ORGANIZATION 9531 — SIGNATURE & NUMBER W. Jones 4075

Figure 7 — Inspection Report

ASQC LCS Code 300:70:419

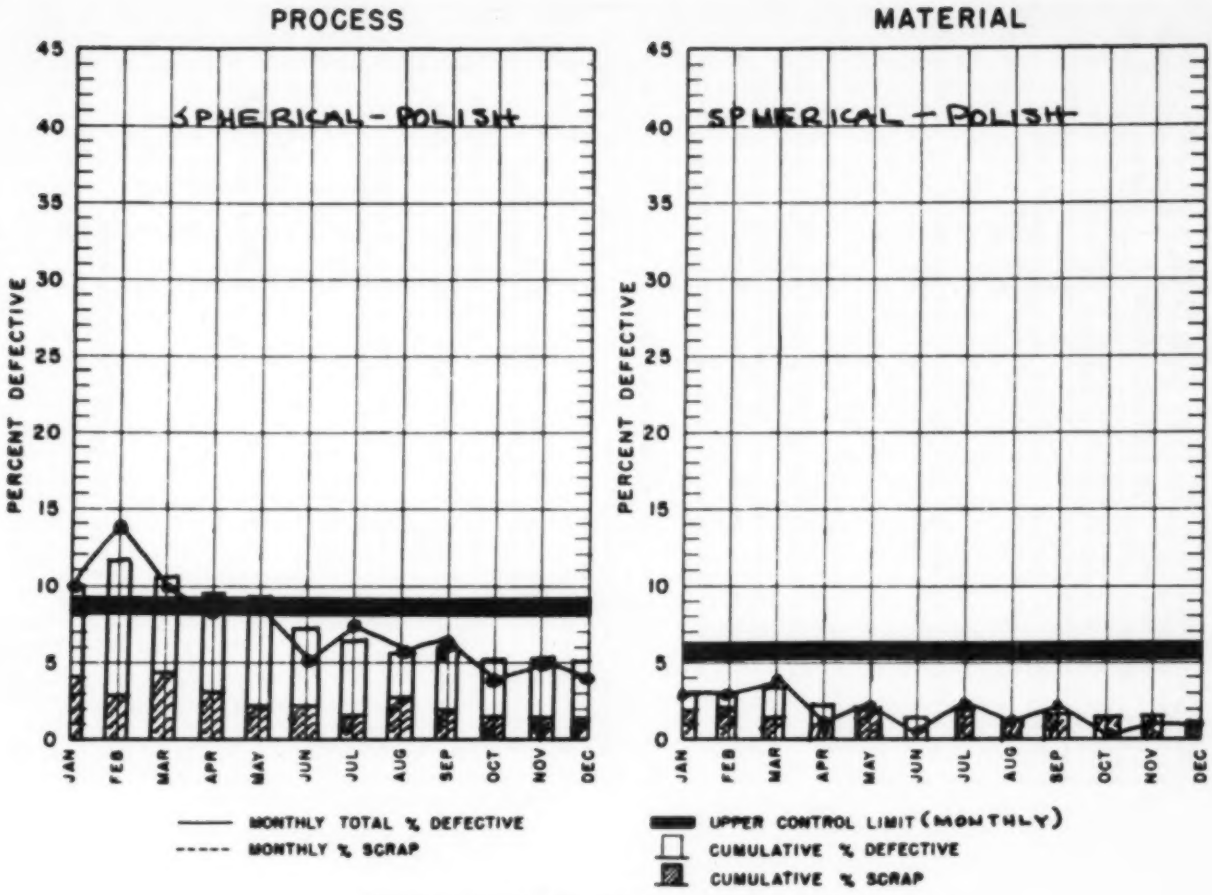

Figure 8 — Monthly Percent Defective Report — 1960

reader to quickly estimate the central tendency and variability values.

Attribute Control Charts ("p" and "c" charts per product and shop)

The attribute control charts, which measure the variability of fractions defective and numbers of defects, are an excellent tool for observing the general stability of process quality. The fraction defective ("p") chart and number of defects ("c") chart are a quick and effective means of isolating quality problem areas. They serve as time saving devices for concentration of effort. Normally, when a product or shop exhibits process stability in the early stages of manufacture, the expenditure of many trouble shooting man-hours is minimized, and more emphasis can be directed toward out-of-control problems.

Process Capability Studies

Process capability studies find wide use during the *Initial Production Run Stage* (Stage II) as well as during the *Process Stabilizing and Regular Production Stage* (Stage III). Failures to meet reasonable specifications result from (1) inadequate process capabilities and/or (2) inadequate operating controls. Knowledge of the existing process capability can help in diagnosing the cause or causes of the failure. Knowledge of machine capabilities and control allowance requirements avoids the dissatisfactions which result from inability to meet specifications and reduces the excess costs involved in over tooling.

The application of process capability concepts in the production-engineering climate is not limited by the generally irregular production or newness of components and assemblies, but due to the small quantities of our orders, smaller sample sizes must be used. Naturally we lose a certain degree of reliability as the sample data decreases. (Data on averages increase in reliability as the square root of the sample size, while data on spread become more reli-

COST CENTER OF SHOP	TOLERANCES	DRAWING LETTER PREFIX				
		A	B	C	D	E&F SKETCHES AND RAD
8511 BUILDING 111-1	FOR TOLERANCES UP TO .015"					FIRST PIECE
8512 BUILDINGS 111-2, 112-2	FOR TOLERANCES UP TO .005"	FIRST PIECE	FIRST PIECE	FIRST PIECE	FIRST PIECE	FIRST PIECE
8513 BUILDING 47	TOLERANCES UP TO .001"	FIRST PIECE	FIRST PIECE	FIRST PIECE	FIRST PIECE	FIRST PIECE
	TOLERANCES UP TO .005"					FIRST PIECE

FIRST PIECE IMPLIES ONLY CHECKING THOSE TOLERANCES LISTED.

Figure 9 — Recommended Areas for First Piece Inspection by Process Inspection

Figure 10 — Frequency Distribution Variable Measurements

FREQUENCY DISTRIBUTION VARIABLE MEASUREMENTS

1. ☐ INCOMING MATERIAL ☐ PROC. INSP. (Comp. Sub-Assy. Compl. Assy) ☒ PROCESS OPERATIONAL ACCURACY

2. DRAWING NUMBER: D-7529371	3. NOMENCLATURE: LEVER	4. END ITEM: RANGE FINDER-M13
5. WORK ORDER: 97065	6. SOURCE OF ITEM: No. FRANKFORD ARSENAL	6a. CONTRACTOR:	6b. NATIONAL STOCK
7. LOT NUMBER:	COST CENTER: 8620 / MACHINE NUMBER: 179-A		REQUISITION NUMBER:
8. ☐ ELECTRICAL ☒ MECHANICAL ☐ OPTICAL	OPERATION NUMBER: 15 / OPERATOR NO: 5307	CONTRACT NUMBER:	DEPOT OR ARSENAL:

9. .430 +.013 LENGTH

No. MEASUREMENT	No. DISTRIBUTION TALLY	f	d	fd	fd²	No. ACTION
.448						
.447						
.446						
.445	I	1	+5	5	25	
.444	II	2	+4	8	32	
.443	III	3	+3	9	27	
.442	IIII	5	+2	10	20	
.441	IIII II	7	+1	7	7	
.440	IIII IIII	10	0	0	0	
.439	IIII IIII III	15	-1	-15	15	
.438	IIII IIII I	11	-2	-22	44	
.437	IIII IIII	10	-3	-30	90	
.436	IIII	5	-4	-20	80	
.435	III	3	-5	-15	75	
.434	II	2	-6	-12	72	
.433	I	1	-7	-7	49	
.432		75		-82	536	
.431						
.430						

PROCESS INCAPABLE OF MEETING .013 TOLERANCE. SUGGEST SHIFT DOWNWARD OF 0.002

M. = 75

$\Sigma x = 82.92$

$\bar{x} = 0.439$

$\sigma = 0.0024$

$\bar{x} + 3\sigma = 0.446$

$\bar{x} - 3\sigma = 0.432$

$\frac{UL - \bar{x}}{\sigma} = \frac{.443 - .439}{.002} = +2.0$

$\frac{LL - \bar{x}}{\sigma} = \frac{.430 - .439}{.002} = -4.5$

Area within = .9779 − .0001 = 97.7 %

Area exceeding = 2.3 %

10. REMARKS:

$\bar{x}$ = Assumed origin + (interval)$\left(\frac{\Sigma fd}{M}\right)$

$\bar{x} = 0.440 + (.001)\left(-\frac{82}{75}\right) = 0.439$

$\sigma = (\text{interval})\sqrt{\frac{\Sigma fd^2}{M} - \left(\frac{\Sigma fd}{M}\right)^2}$

$\sigma = (.001)\sqrt{\frac{536}{75} - \left(\frac{82}{75}\right)^2}$

$\sigma = 0.0024$

11. DATE: 11-7-60	12. INSPECTION AREA: 9510	13. INSPECTOR: 0520

ORDBA Form 2963 26 Feb 59

INDUSTRIAL QUALITY CONTROL

Figure 11 — Quality Control Instruction

QUALITY CONTROL INSTRUCTION

NO. 19-61 REV. ___ DATE 5-11-61 PAGE 1 OF 2

FROM: Qual. Control Sec
Production Eng'rg Br.
Ch., Proc. Insp. Ofc.
Attn: Mr. Dettore (9510)

SUBJECT: Fuse Components Heat Treated in Bldg. 250 and Submitted to Process Inspection Ofc. (9512)

PURPOSE: To establish an acceptance sampling program for the hardness characteristic of the subject components.

REFERENCE: Mil. Std. 414, "Sampling Procedures and Tables for Inspection by Variables for per Cent Defective"

INFORMATION OR PROCEDURE:

1. Process Inspection (9512) will determine the classification of characteristic best describing the hardness requirement; Critical, Major or Minor. This determination will be made by consulting the appropriate purchase description, drawing, or the Methods Engineering Section (9620).

2. a. When hardness is classified as Critical, it must be inspected 100%.

b. When hardness is classified as Major or Minor, Mil. Std. 414, "Sampling Procedures and Tables for Inspection by Variables for per Cent Defective," will be employed. An AQL of .25% will be used for Major type hardness characteristics, and an AQL of .40% will be used for Minor Characteristics.

The "Variability Unknown - Average Range Method" of calculation with its associated sample sizes, is recommended.

3. a. If the hardness characteristic of a subject lot meets the acceptability criteria of Mil. Std. 414, it shall be accepted by Process Inspection, and an Inspection Report (ORDBA-3083) will be initiated.

b. If the hardness characteristic of a subject lot fails to meet the acceptability criteria of Mil. Std. 414, Process Inspection will notify Methods Engineering Section (9620) as well as process an Inspection Report (ORDBA-3087).

CONCURRENCE: J. BRAVERMAN, Ch., Qual. Control Sec. (9650)

APPROVED: A. R. HEWITT, Ch., Prod. Eng'rg. Br. (9600)

ORDBA FORM 3287 19 DEC 60 (SUPERSEDES EDITION OF 30 OCT 60)

able as the square root of twice the sample size.) However, because we are willing to risk a certain decrease in accuracy, we employ capability studies using 50 to 100 pieces on potential trouble spots. The important thing is that the statistical analysis of small samples still gives a better estimate of the process or product than an intuitive decision does. An example of a capability study is presented in Fig. 10.

Quality Control Instructions to Process Inspection

The carrying out of a quality control technique, method, or plan involves — in many cases — assistance and participation by Process Inspection.

Written instructions must be made available to the process inspectors to prevent misunderstandings, oversights and the like. These instructions are of particular importance in the production-engineering climate, because many times there is no second chance to run the job. Figure 11 is an example of a Quality Control Instruction form. Such instructions can include variable control charting methods, procedures for carrying out a special test, changes in sampling frequency, the initiation of a process capability study, or the application of a new piece of test equipment.

Audit Product and Process Quality Results and Initiate Corrective Action

Auditing of product and process quality results identifies significant quality problems.

"Significant," in the production-engineering case, means out-of-control mortality, heavy dollar losses, noticeable interruptions in processing, functional shortcomings, inspection inaccuracies, unrealistic specifications, etc.

Auditing includes daily shop visits to observe attribute and variable control chart results, results of special tests; review of daily, weekly and monthly quality trends and costs; and evaluation of incoming and outgoing quality. Corrective action on problem cases usually demands a team approach. The team consists of a small number of people, each of whom can contribute something to the solution of the problem. The corrective measures in process and product control are frequently elusive to the quality control group. While there are basic statistical tools (capability study, control chart, regression study, significance tests) that we can use, there are many times when the right answer escapes us. It is here that the team approach is of immeasurable value.

Training in Quality Control Techniques

Before training in quality control methods and techniques is given to process inspectors, methods engineers, and supervision, their backgrounds and positions in the organization are considered. We teach the simple concepts or try to fill a particular need during the classes which average two hours a meeting. Ample handouts and demonstrations accompany each class session. Regardless of the type of individual in the class, his interest must be aroused in order to take the statistical quality control concepts and application away from the "mystic" stage and into the useful tool stage. Actually, we look upon training from the standpoint of a "Problem-Solving Clinic."

Simple demonstration devices are used wherever possible. Little or no homework is required, since on-the-job application can indicate the degree of proficiency attained.

Subject matter covered includes:

- Frequency distribution study
- Variable control charting
- Attribute control charting
- Attribute sampling
- Variable sampling
- Accuracy in reporting
- Inspection short-cuts
- Gaging accuracy
- Inspection-production relationships

We feel that training in quality control methods and techniques is a continuing thing necessitated by personnel turnover, greater amplification of basic fundamentals, newer ideas, etc.

TABLE I—Coordination of Quality Control and Process Inspection

Quality Control	Process Inspection
1. Provide Lot Sampling Plans and Machine Inspection Plans	1. Provide First Piece Inspection, Machine Inspection, Lot Sampling Inspection, and 100 Percent Inspection
2. Develop Reporting System Analyze Data Issue Appropriate Reports of Quality	2. Feedback Product and Process Quality Data
3. Analyze Data Suggest Approaches to the Study of Problems	3. Provide Daily Shop Trouble Shooting of Product and Process Quality Problems
4. Develop and Test Sampling Plans	4. Apply New, Modified or Revised Sampling Plans
5. Develop and Test Quality Control Plans and Procedures	5. Apply and Assist in Developing Quality Control Plans and Procedures
6. Develop and Recommend Application of Preventive Measures	6. Apply Preventive Measures
7. Measure Dollar Value of Scrap and Rework and Study Shop and Process Quality Trends	7. Identify and Report Defective Material
8. Experiment With New Gaging and Measuring Devices	8. Test New Gaging and Measuring Devices
9. Provide Training and Orientation in Quality Control Techniques	9. Apply New Quality Control Techniques
10. Study Outgoing Quality Rates and Make Recommendations to Process Inspection	10. Adjust Inspection Activity in Line With "Customer Needs"
11. Monitor, Review, and Maintain Active Case History Files	11. Prepare Reports: Rejection, First Piece, Lot Inspection, Frequency Distribution, Quality Problem, and Material Review Committee

Development of New Techniques for Analysis of Quality Problems

The development of new techniques for attacking and analyzing quality problems follows the familiar phrase, "there is a better way to do it — find it." Often the statistical and engineering man-hours involved in solving a quality problem become monumentally costly, and do not provide the answers in sufficient time for practical purposes. Such situations have forced quality control to explore short and rapid statistical techniques — nomographs, tables, charts — as adjuncts to the more sophisticated techniques.

We find that a dual approach to the use of statistical techniques in the production-engineering climate works best — both the more accurate detailed tests and the short and rapid tests are considered. Naturally, with the short and rapid tests, there is a decrease in efficiency which must be recognized. (See Appendix 2.) Basically, it is a matter of balancing the decrease in accuracy of one answer with the increase in precision, time, and manpower necessary to obtain a more reliable answer.

Coordinate Quality Control and Process Inspection Effort

In view of the variety of quality control techniques employed and problems encountered by process inspection, the coordination of quality control and process inspection activities is essential during the Initial Production Run stage; many new ideas and techniques are tested at this time for feasibility of application during Stage III. An example of this coordination appears in Table I.

Stage III — Process Stabilization and Regular Production

In Stage III, there is a general stabilizing of quality effort. Some settling down or elimination of significant defects occurs. This stage continues through to the completion of the order.

Comprehensive Management Report of Product and Process Quality

Comprehensive reporting in Stage III keeps management informed of product quality, types of leading defects, out-of-control conditions, losses due to scrap, and corrective measures taken. Reports to and from management regarding product and process quality also clarify the problems that must be solved.

We strive for clear, concise reports. It should be pointed out that in the production-engineering type climate, with its wide variety of items of low and medium density, reports may snowball in size if they are to accommodate the many components, assemblies, and processes. Such reports are cumbersome and lose their effectiveness. To prevent this our reports incorporate simple histograms, line charts, and numerical summaries. They highlight out-of-control conditions. It is truly a challenge to present a brief report which contains the key elements and really captures

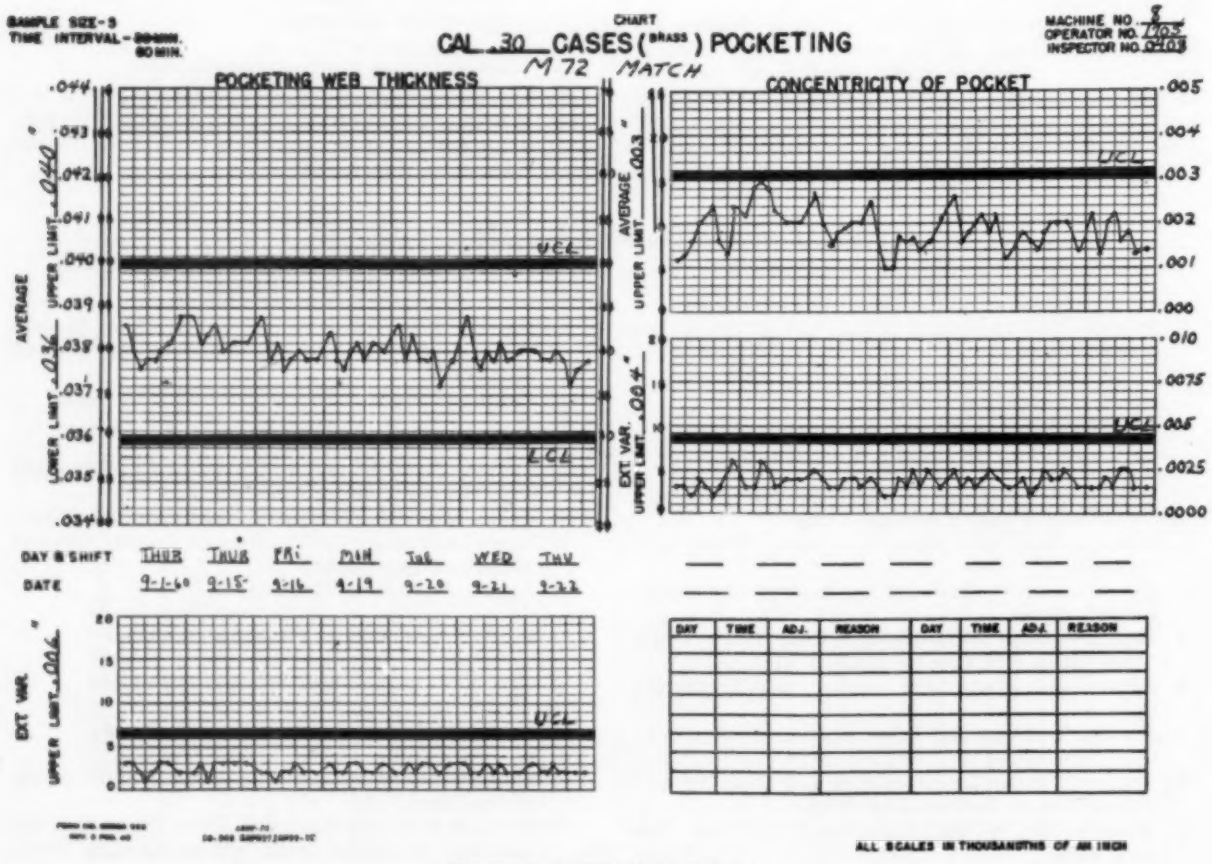

Figure 12—Variable Control Chart

management's attention. Actually, the purification of reporting to meet the company's needs is a continuing problem.

Statistical Studies on Product and Process Quality Problems

The statistical techniques most frequently used in our production-engineering climate are the frequency distribution analysis, correlation analysis, significance tests, analysis of variance, and design of experiments. Some applications of each of these five techniques are described below:

a. *Frequency Distribution Analysis*
   (1) Process capability studies
   (2) Dimensional changes of a part during various stages of machining
   (3) Ballistic results of artillery ammunition
   (4) Consistency of the accuracy results of small arms ammunition

b. *Correlation Analysis*
   (1) Physical change in ammunition after heat-treatment
   (2) Dimensional changes in fire control and ammunition parts with the application of various processing techniques
   (3) Relationship of ammunition accuracy between results at 300 yards compared to results at 600 yards
   (4) Absenteeism of inspectors due to weather conditions

c. *Significance Tests*
   (1) Ammunition accuracy between "defective" and defect-free cartridges
   (2) Comparison of the average and variability of product quality from various sources of supply
   (3) Comparison between an expected test result and an observed test result for ammunition
   (4) Accuracy of decisions between inspectors
   (5) Inspection results when using different fire control test fixtures

d. *Analysis of Variance*
   (1) Effect that different ammunition and different guns have on accuracy
   (2) Effect that working days have upon male and female inspectors
   (3) Effect that different pull-test methods and bonded assemblies have upon pull-test results
   (4) Effect of machines and operators upon product quality

e. *Design of Experiments*
   (1) To evaluate ammunition accuracy and gun effect at different ranges, considering order of firing ammunition in guns, method of cooling, and period of gun usage
   (2) To evaluate a new process
   (3) To study functional results of new design under varying loads, temperatures, pressures, etc.

Study of these techniques is recommended by reference to available text books; some of which are listed in the references of this article.

Review and Adjust Sampling Plans

Changes in product variability, economics of inspection, dollar value of material, outgoing quality rates, requirements, or modifications in processing, demand a re-evaluation of inspection plans for possible adjustment or replacement. This entails a close re-examination of the "O-C" curve, AOQ curve, sample size, acceptance-rejection criteria, amount of inspection curve, and administration of the plan. For example, consistently good, outgoing quality can make possible a change from a single-sampling plan on a class basis to a multi-level, continuous sampling plan on a characteristic basis, resulting in very noticeable savings in inspection man-hours. Or a sensitive single-sampling plan can be effectively replaced by a double-sampling plan when quality is consistently either very good or very bad. Again, machine inspection with variables control charts might be reduced from subgroup samples of five per hour to five per two hours or one piece per hour, based upon the stability of the constant-cause system. Variables sampling plans replace attributes sampling plans when conditions are right, thereby reducing sample sizes noticeably. Numerous other types of sampling plans can be modified or replaced frequently.

Variables Control Charts ($\bar{X}$ and R).

It is impractical to indiscriminately apply variables control charts in the production-engineering climate because the manpower needs are prohibitive. Therefore, attention is directed only toward quality problems such as: (a) leading defects, (b) close tolerances that can be the source of trouble, (c) characteristics on components contributing to assembly difficulties, (d) past repetitive failures in meeting requirements on similar parts, (e) important physical or functional tests, (f) machine groups that have been out-of-control on a fraction defective basis, and (g) new or modified machines. Usually, $\bar{X}$ and R charts are employed with subgroup sample sizes up to ten pieces, but occasionally, $\bar{X}$ and σ charts are used with subgroup sample sizes of 12 to 15 pieces.

Every control chart that is placed out in the shops is originally designed by quality control on a reproducible form (Fig. 12) and then turned over to process inspection, along with reproduced copies. The time saved by reproducing copies has been most significant. Control charts are maintained by process inspection, and monitored by quality control. When the need for such charting is eliminated the charts are immediately removed.

Audit Product and Process Quality Results

Complacency and rigidity of industrial operations is tantamount to industrial suicide in today's market of complex equipment. It is necessary to constantly audit performance to determine past, present, and future capabilities.

From these determinations, various courses of action can be pursued, ranging from purely informational and advisory to major changes in method, manufacturing, or design.

Auditing includes:

(a) Weekly review and analysis of "Leading Defects"
(b) Monthly review and analysis of "Shop Process and Product Quality"
(c) Monthly review and analysis of process averages and sampling effectiveness
(d) Monthly review of scrap dollar losses for shop and product
(e) Quarterly appraisal of inspection costs compared to scrap dollar losses
(f) Continuous monitoring of variables and attributes control charts maintained on quality problems or leading defects

(g) Periodic appraisal of adherence to quality assurance plans and procedures
(h) Analysis of outgoing product quality levels and problems
(i) Appraisal of product and process quality from new processes
(j) Analysis of field complaints

The audit results serve as a basis for adjustment in processing or inspection, directly toward the realization of optimum performance.

Analysis of Quality Problems for Feedback to Design Engineers and Methods Engineers

A good working relationship should exist between the design engineer, methods engineer, and quality control engineer for the evaluation of product quality before the start of regular production, during the stages of prototype manufacture and in the course of regular manufacture.

The quality control engineer contributes to the feedback cycle to design and methods engineers by working on the:

(a) realism of specifications,
(b) practicality of tolerances,
(c) test sample sizes,
(d) evaluation of inspection and test results,
(e) compatibility of tolerances with machining capabilities,
(f) quality control planning,
(g) design of industrial experiments,
(h) developing of a quality index or a composite picture of the final product quality, and
(i) application of advanced gaging.

The contributions made by the quality control engineer are both engineering and statistical. The closer the quality control engineer stays to the new or modified design, the more effective is the prevention of quality problems. Concentrated effort devoted to the details in the early interval of the product growth eliminates much trouble-shooting during manufacture.

Analysis of Costs of Achieving and Maintaining Product and Process

The acid test most frequently used by management in evaluating the efficiency of the quality activity is the cost of its operation. The economics of quality in the Operations Division is judged by the proportion of the scrap dollars to the production dollars. Comparisons are maintained and studied monthly for each of the major manufacturing shops and for each major type of production item. Actually, the comparison is expressed in terms of a simple percentage index (I):

$$I = D/P \times 100$$

where

I = % (index)
D = accumulative dollar value of scrap material
P = accumulative production dollars expended

Each month, the complete dollar picture is presented to management, with appropriate recommendations. From this economic appraisal, various courses of action are pursued. This might include (1) adjustment in inspection for more effective control measures at the operation(s) causing significant defects, (2) closer supervision devoted to certain products or operations, (3) re-evaluation of the process by methods engineering, (4) different tooling needs, (5) changes in material, etc. (See Fig. 13.)

Conclusion

There is no one best way of controlling quality in the production-engineering type of industry. On the other hand, the science and management of quality control has advanced sufficiently to offer numerous ideas and techniques for coping with particular situations. In this article, an attempt has been made to describe an approach to the control of quality in an industrial climate where planning, control and manufacturing are faced with a wide variety of low density items which range through all degrees of complexity. Practical quality control applications, together with theoretical techniques have been tailor-made to meet the need.

This discussion has been presented in the sincere belief that regardless of the system employed in controlling and assuring quality, there must be integrated and systematic thinking. The increasing demands for precision in military and consumer goods demands that quality control people effectively design their operations.

Acknowledgment

Often when an article is presented describing the experiences gained in a particular company, little or no credit for freedom of expression and direction is given to the company's management. The writer is grateful to George Ripka, deputy chief, Operations Division and Arthur Hewitt, chief, Production Engineering Branch of the Frankford Arsenal, who were directly responsible for this opportunity. While progress comes about from inspiration and perspiration, it is a rational type of management that provides the catalyst for advancement.

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Appendix 1
Quality Assurance Provisions

These quality assurance provisions pertain to: Case, Cartridge, C-8593354 Rev. C, Part No. 8593633, Propellant Actuated Device.

1. *Classification of Defects*

Defect	Method of Inspection
A. CRITICAL	
(1) Metal Defective (cracks, splits, cold shuts, inclusions, laminations, perforations, porosity or any similar defect)	Visual

B. MAJOR

(1) Concentricity of large diameter with small diameter	Gage
(2) Length to datum diameter	Gage
(3) Thickness of base	Gage
(4) Thickness of wall	Gage
(5) Mouth chamfer missing or incorrect	Visual
(6) Protective finish inadequate or defective	Visual
(7) Foreign matter	Visual

C. MINOR

(1) Small diameter	Gage
(2) Large diameter	Gage
(3) Total length	Gage
(4) Flatness of base	Gage
(5) Radius missing or incorrect	Visual
(6) Surface finish, improper	Visual
(7) Burr or sharp corner	Visual

2. *Examination* — One hundred percent examination shall be performed for all critical defects. Examination for major and minor defects shall be performed in accordance with Standard MIL-STD-105 on a single defect basis. The AQL shall be 0.25 percent for each major defect and 0.40 percent for each minor defect. Four power (4X) magnification may be used to perform visual examination for such defects as burr and foreign matter.

3. *Government Verification* — Government product inspection will be used to verify the quality of product offered for acceptance. The product inspection will employ MIL-STD-105B, "Sampling Procedures and Tables for Inspection by Attributes," making use of the AQL's listed in paragraph 2, "Examination."

Appendix 2
A Comparison Between Detailed and Rapid Statistical Test

Problem #1—Close tolerance, leading defect, potential processing problem, or capability of process desired

A. Customary Statistical Technique: *Process Capability Study*

1.1 Select 100 to 200 consecutive pieces from an approved process

1.2 Study the frequency distribution of readings and calculate:

$$\bar{x} = \frac{x_1 + x_2 + \ldots + x_n}{n}$$

$$S = \sqrt{\frac{x_1^2 + x_2^2 + \ldots x_n^2 - \bar{x}^2}{n}}$$

$$\hat{\sigma} = \sqrt{\frac{n S^2}{n - 1}}$$

where,

$\bar{x}$ = arithmetic mean

x_1, x_2 = specific observed values

n = sample size

S = standard deviation of sample

$\hat{\sigma}$ = standard deviation of population (estimated)

1.3 Calculate the process capability:

$$\text{Process Capability} = 6\hat{\sigma}$$

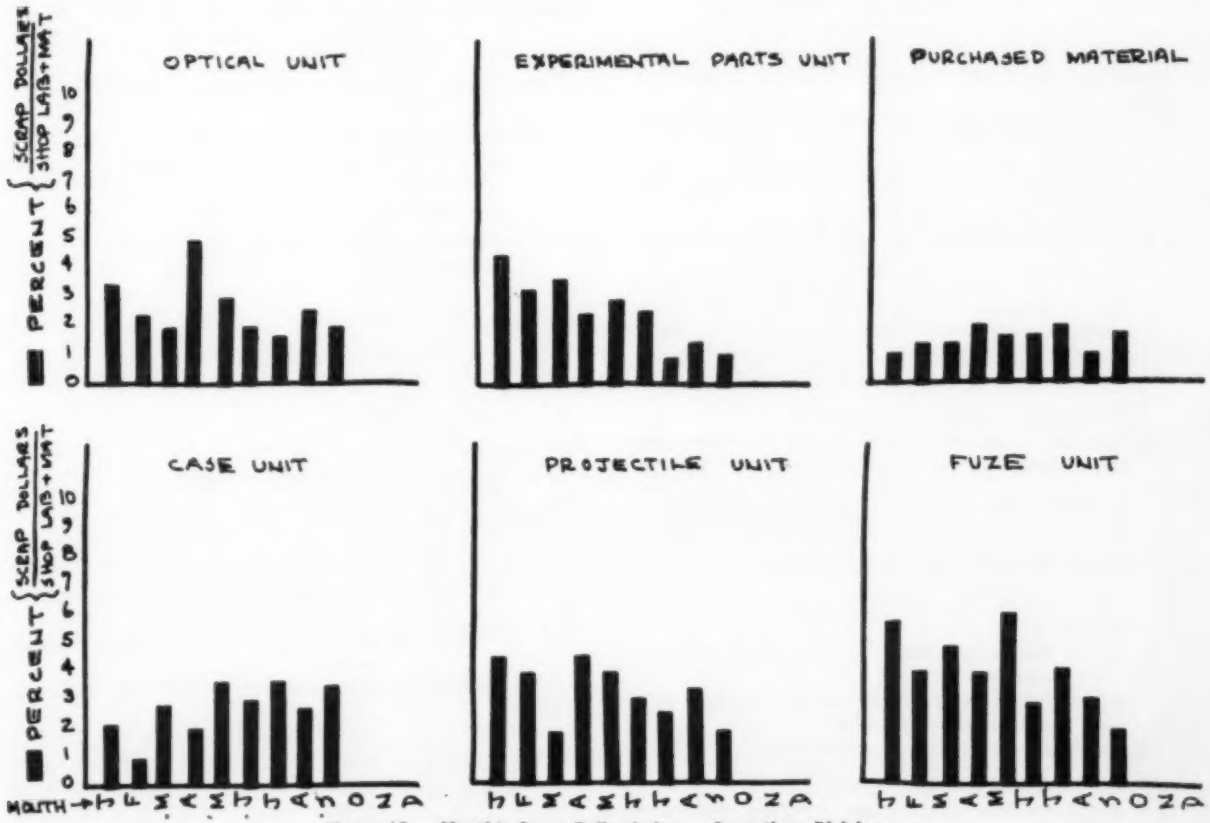

Figure 13 — Monthly Scrap Dollar Index — Operations Division

1.4 Analyze frequency distribution for skewness and kurtosis

$$a_3 = \frac{m_3}{(m_2)^{3/2}} \text{ (skewness)}$$

$$a_4 = \frac{m_4}{(m_2)^2} \text{ (flatness)}$$

where,

$$m_2 = \frac{\Sigma(x - \bar{x})^2}{n},$$

$$m_3 = \frac{\Sigma(x - \bar{x})^3}{n},$$

$$m_4 = \frac{\Sigma(x - \bar{x})^4}{n}$$

1.5 Solve for the estimated population fraction defective from sample results by performing the following:

$$Z_1 = \frac{\text{Upper Limit} - \bar{x}}{\hat{\sigma}}$$

$$Z_2 = \frac{\text{Lower Limit} - \bar{x}}{\hat{\sigma}}$$

A_1 = Area from $-\infty$ to Z_1
A_2 = Area from $-\infty$ to Z_2

where,

$A_1 - A_2$ = area between specification limits (fraction good)
$1 - (A_1 - A_2)$ = area outside specification limits (fraction defective)
A_2 = fraction defective below lower specification limit
$1 - A_1$ = fraction defective above upper specification limit

B. Short-Cut Technique: *Limited Process Capability Study*

1.1 Select 15 consecutive pieces from an approved process

1.2 Visually study frequency distribution for "normality"

1.3 Determine range (R) of 15 pieces

1.4 Estimate standard deviation of individual values ($\hat{\sigma}$) from range. The range can be used for estimating the standard deviation only when the universe being sampled is near normal, and in wide majority of industrial quality control situations, this is the case. For a 15 piece sample: $\hat{\sigma} = 0.288R$

1.42 The use of sample quasi-ranges in estimating the standard deviation can also be employed to realize an increase in efficiency of the $\hat{\sigma}$. For a sample size of 15 pieces, a 92% efficiency for estimating $\hat{\sigma}$ can be realized by:

$$\hat{\sigma} = 0.1546\ (w_0 + 1.2011\ w_1)$$

where
w_0 = range between largest and smallest number
w_1 = range between second largest and second smallest number

1.5 Calculate the process capability:

$$\text{Process Capability} = 6\hat{\sigma}$$

1.6 Estimate the population fraction defective from sample results by referring to the circular nomograph for "Area Under Normal Curve" (Fig. 14).

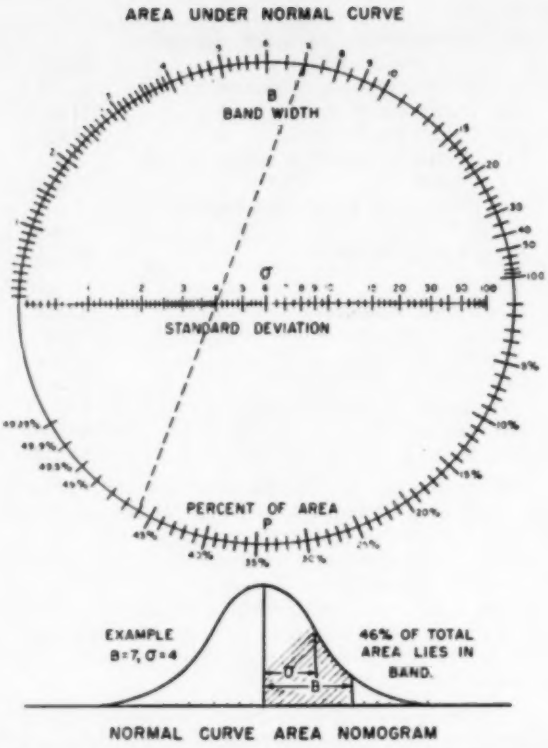

Figure 14—Area Under Normal Curve and Normal Curve Area Nomograms

Problem #2—Significant defect, processing problem, important characteristic, or potential quality difficulty

A. Customary Statistical Technique: *Variables Control Charting*

2.1 Accumulate about 25 subgroups (sample sizes of 4, 5 or 6 per subgroup) of measurements, where each subgroup is usually selected from the machine every few hours.

2.2 Calculate control limits for average ($\bar{X}$) and ranges (R) of subgroups

$$\bar{\bar{X}} = \frac{\Sigma \bar{X}}{n}$$

$$UCL_{\bar{x}} = \bar{\bar{X}} + A_2\bar{R};\ LCL_{\bar{x}} = \bar{\bar{X}} - A_2\bar{R}$$

$$\bar{R} = \frac{\Sigma R}{n}$$

$$UCL_R = D_4\bar{R};\ LCL_R = D_3\bar{R}$$

where,

$\bar{\bar{X}}$ = grand average of subgroup average
$\bar{R}$ = average range of subgroup ranges
n = number of subgroups
$UCL_{\bar{x}}$ = upper control limit for average chart
$LCL_{\bar{x}}$ = lower control limit for average chart
UCL_R = upper control limit for range chart
LCL_R = lower control limit for range chart
A_2, D_3, D_4 = factors for average and range charts depending upon sample size n, of subgroup (See Table II)

2.3 Compare subgroup averages and ranges with control limits to determine constant cause system (values within control limits) or assignable cause system (values outside control limits).

2.4 Determine variability of individual measurements and estimate of process from:

$$\sigma' = \frac{\bar{R}}{d_2}$$

where,

σ' = estimate of standard deviation of universe of individual measurements

$\bar{R}$ = average range of subgroup ranges

d_2 = factor for estimating (σ') from ($\bar{R}$), when sampling from Normal universe (See Table II)

2.5 Calculate estimate of process from

Estimate of process = $6\sigma'$

2.6 Compare the estimate of process ($6\sigma'$) to tolerance range, and take appropriate action.

B. Short-Cut Technique: *Limited Variable Control Charting*

2.1 Set up temporary control limits on the average ($\bar{X}$) and range (R) charts for the given dimension without benefit of any prior information or without any preliminary process capability study.

2.2 Tne temporary control limits are set up under the assumption that the six sigma ($6\sigma'$) spread of the distribution obtained from the process coincides with the tolerance range of the drawing. Thus, if T is the drawing tolerance range, then

$$T = 6\sigma'$$
$$\sigma' = T/6$$

however,

$$\sigma' = \bar{R}/d_2 = T/6$$

therefore,

$$\bar{R} = d_2\, T/6$$

and for sample sizes of five, where $d_2 = 2.326$, we obtain:

$$\bar{R} = 0.388T$$

2.3 Substituting this expression for R into the equation for control limits, we have: (For $n = 5$)

$$UCL_{\bar{x}} = \bar{X}_m + 0.23T;$$
$$LCL_{\bar{x}} = \bar{X}_m - 0.23T$$
$$UCL_R = 0.82T; \quad LCL_R = 0$$

where,

$\bar{X}_M$ = assumed mean of drawing

T = tolerance range

2.4 Where the defect or quality problem has improved, variables control charts can be either removed, or continued using a smaller subgroup sample size of perhaps two pieces. The control limits are now computed by calculating the $\bar{R}$ from about 10 to 15 sample subgroups ($n = 5$) immediately preceding the adjustment in subgroup sample size, and solving for $\sigma' = \bar{R}/d_2$

Table II — Selected Values of Control Chart Factors

n	A_2	D_3	D_4	d_2
4	0.73	0	2.28	2.059
5	0.58	0	2.11	2.326
6	0.48	0	2.00	2.534

Next calculate

$$UCL_{\bar{x}} = \bar{X}_M + A\sigma;\ LCL_{\bar{x}} = \bar{X}_M - A\sigma;$$
$$UCL_R = D_2\sigma;\ LCL_R = D_1\sigma$$

where, for $n = 2$

$A = 2.12$

$D_1 = 0$

$D_2 = 3.69$

$\bar{X}_M$ = mean of drawing

Problem #3—Control of process and product mortality

A. Customary Statistical Technique: *Attribute Control Chart*

3.1 To determine the presence of assignable causes of variation associated with fraction defective rates, consider the attribute control chart ("p" Chart).

3.2 Using the standard deviation of the fraction defective as $\sqrt{\bar{p}'(1-\bar{p}')/n}$ compute control limits as follows: (assume $p' = \bar{p}$)

$$UCL_p = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

$$LCL_p = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

where,

$\bar{p}$ = observed average fraction defective

p' = true process average fraction defective

n = number inspected (daily, weekly, monthly, etc.)

UCL_p = upper control limit for fraction defective

LCL_p = lower control limit for fraction defective

B. Short-Cut Technique: *Limited Attribute Control Charting*

3.1 Determine control limits for "p" chart by employing the circular nomograph in Fig. 15 which solves for $3\sqrt{\bar{p}\,(1-\bar{p})/n}$

Problem #4—Investigate the relationship between two variables, or the effect that the related variable x has upon the basic variable y.

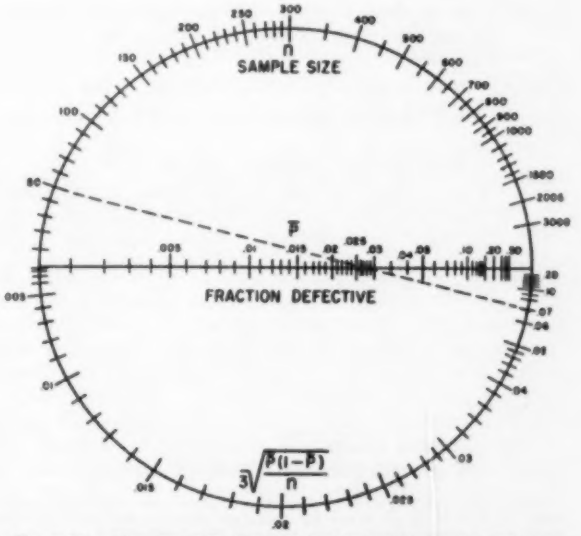

Figure 15 — Nomograph for Determining Control Limits of "p" Chart

A. Customary Statistical Technique: *Correlation Study*

4.1 Using the slope-intercept method, solve for the regression line

$$Y_r = a + bX$$

where,

$$a = \text{intercept} = \frac{\Sigma Y - b\,\Sigma X}{n}$$

$$b = \text{slope} = \frac{n\,\Sigma XY - \Sigma X\,\Sigma Y}{n\Sigma X^2 - (\Sigma X)^2}$$

n = pairs of observations

4.2 Then solve for the correlation coefficient, r, and the standard error estimate, S_y

$$r = \sqrt{\frac{a\,\Sigma Y + b\,\Sigma XY - n\,\bar{Y}^2}{\Sigma Y^2 - n\,\bar{Y}^2}}$$

$$S_y = \sqrt{\frac{\Sigma Y^2 - a\,\Sigma Y - b\,\Sigma XY}{n}}$$

B. Short-Cut Technique: *Limited Correlation Study*

4.1 Test whether two variables are correlated by checking the correlation between their ranks, using the Spearman rank—correlation test.

4.2 Compute the standard normal variable, K*

$$K = \frac{n(n+1)(n-1) - 6(\Sigma d^2 \pm 1)}{n(n+1)\sqrt{n-1}}$$

where,

$$\pm = \begin{cases} + \text{ if } 6\,\Sigma d^2 < n(n+1)(n-1) \\ - \text{ if } 6\,\Sigma d^2 > n(n+1)(n-1) \end{cases}$$

n = number of pairs of observations

d^2 = sum of squared differences in rank

Problem #5—Significance tests on data

5.1 Test to determine if different samples belong to normal populations having the same mean and variance (L_0 test)

$$L_0 = \left(\frac{S_1^2 \cdot S_2^2 \ldots S_i^2 \ldots S_K^2}{S_0^2 \cdot S_0^2 \ldots S_0^2 \ldots S_0^2} \right)^{1/k}$$

where,

S_i^2 = within sample variance

S_0^2 = variance based upon the derivation of all N observations about their mean $\bar{X}$ (The distributions of L_0 have been approximated and tables have been prepared).

k = number of samples

5.2 Test to determine if different samples belong to normal populations of the same variance (L_1 test)

$$L_1 = \left(\frac{S_1^2 \cdot S_2^2 \ldots S_i^2 \ldots S_K^2}{S_a^2 \cdot S_a^2 \ldots S_a^2 \ldots S_a^2} \right)^{1/k}$$

where,

S_i^2 = within sample variance

S_a^2 = mean of the within-sample variances

5.3 Test to determine the difference in variability in two independent samples selected from normal populations where the means are the same (F test)

$$F = \frac{\hat{\sigma}_1^2}{\hat{\sigma}_2^2}$$

where,

$$\hat{\sigma} = S\sqrt{n/n-1}$$

S = standard deviation of sample

5.4 Test to determine if there is a difference between two sample means where the standard deviation of the population is not known, but assumed to be the same for both populations (t test)

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\hat{\sigma}\sqrt{\frac{n_1 + n_2}{n_1 n_2}}}$$

$$\hat{\sigma} = \sqrt{\frac{n_1 S_1^2 + n_2 S_2^2}{n_1 + n_2 - 2}}$$

where,

$\hat{\sigma}$ = estimate of standard deviation of the population

S_1 & S_2 = sample standard deviations

$\bar{X}_1$ & $\bar{X}_2$ = sample means

B. Short-Cut Technique: *Limited Significance Testing*

5.1 A test to compare the averages of two populations on the basis of two independent samples can be performed by the use of the Wilcoxon two-sample test. All observations of both samples are combined and ranked. The approximate standard normal variable (K) is calculated by

$$K = \frac{2R \pm 1 - n(N+1)}{\sqrt{\frac{n(N+1)(N-n)}{3}}}$$

where,

R = sum of the ranks of either sample

n = sample size from which R is taken

N = number of observations in both samples

$$\pm = \begin{cases} - \text{ if } 2R > n\,(n+1) \\ + \text{ if } 2R < n\,(N+1) \end{cases}$$

(Having the value K, you refer to the tables of the standard normal distribution to find the required probability. Such tables show the probability of a value larger than any particular K. The probabilities in these tables are usually either upper-tail type or the two-tail type. As a rough guide to the significance atttached to your K value, if K is 1.96 or greater, it can be assumed that there is more than chance between or among the samples. This is considering a 95 percent probability that a normal distributed variable is within $\pm$ two standard deviations of the mean. That probability is 95 percent for K = 1.96).

5.2 A test to compare the average of several populations on the basis of several independent samples can be had by employing the Kruskal-Wallis test. All observations of all samples are combined and ranked. The standard normal variable is computed from

$$K = \sqrt{2H} - \sqrt{2k - 3}$$

where,

$$H = \frac{12}{N(N+1)} \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3(N+1)$$

R_i = sum of ranks in i-th sample

n_i = number of observations in i-th sample

N = number of observations in all samples

k = number of different samples

(See the explanation above in 5.2 for handling K).

* K is normally distributed, but its mean and standard deviation are 0 and 1; knowing K, you can refer to the table of the standard normal distribution to find the probability of a value larger than any particular K.

Editorial Note

The following report is the result of a project undertaken by the Measurement Survey Team of the Aerospace Industries Association and sponsored by Sperry Gyroscope Company, Division of Sperry Rand Corporation, Great Neck, N.Y. The members of the AIA Measurement Survey Team are Chairman Frank McGinnis, Harry Martin, John Novotny, and Lloyd Wilson.

The Sleeping GIANT of the Sciences Awakens

THE KEYSTONE SCIENCE—that upon which all technological advancement depends—is metrology, the science of measurement. Progress in metrology, although significant, has not kept pace with the soaring accomplishments of some of those johnny-come-lately technologies like thermonuclear power, ultrasonic aerodynamics, and ionospheric communications. The door to many new and important discoveries can be unlocked only if greater accuracies can be attained in those fields of measurements upon which these new sciences depend. The giant of metrology is beginning to stir itself and take strides to close the lead.

You may well wonder how it is possible, with all the eye-opening engineering achievements we read about, for something as basic as the ability to measure to be outdistanced. We must all agree that things have been happening on the scientific frontier with bewildering rapidity. It just isn't possible to look in all directions at one time, plus the fact that the spur of incentive has been put to other areas. Our scientists, engineers and educators, and our congressmen as well, have had their eyes on the more colorful aspects like the arms race, space travel, impact of science on world prestige, etc. There just wasn't time to look over their own shoulders to make certain that the foundation was being strengthened to accommodate the additional load. Metrology is that foundation.

U.S. Air Force Makes First Move

Perhaps the first real alarm that was sounded came from Colonels J. G. Schneider and Richard Stolle of the Air Force's Air Materiel Command, Quality Control group at Wright-Patterson AFB. They requested the AIA (Aerospace Industries Association) to question its member companies regarding their needs for improved calibrations and standards. In February 1959, the Quality Control Committee of the AIA, with Sperry Gyroscope Company as project sponsor, conducted a comprehensive survey which pinpointed specific areas of measurement that needed attention. This survey, which had the complete cooperation of the National Bureau of Standards, uncovered the perilous state of metrology in this nation. Much publicity was given the situation then and since. Powerful forces were set in motion to awaken the sleeping giant. Although momentum is gathering to overcome the problem, serious deficiencies exist.

Just where are we lacking in our ability to measure? We desperately need new and improved standards in many categories of measurement as well as the procedures, instruments and training to calibrate against them. For example, there are no satisfactory working standards for the measurement of radio-frequency interference. A standard for million-pound-thrust must be established

ASQC LCS Code 700:00:000

before our rocket engines can be improved to meet the requirements of certain advanced projects. In optical measurements, a standard sky brightness for "Full Daylight" is needed for astro-tracking. At present, there is no way to make dependable calibrations of infrared, pulse voltage, RF voltage, microwave peak power or microwave noise. These are only a few. The list is long. The need is urgent.

In addition to the above there is, in many companies, a lack of centralized management control over calibration programs. There is a general lack of traceability of corporate standards to the national standards on a valid calibration basis. There is a need for increased accuracies in many fields of measurement—all of which adds up to a system which does not speak well for our level of attainment in the science of metrology.

Attention Is Directed to the Problem

In order to alert the nation to the seriousness of the shortcomings in attaining extreme accuracies, much publicity was given the problem. A press conference was held at the public release of the Industry Calibration Survey. Many newspapers and industry magazines picked up the story and stimulated further interest. Many military people, such as Lt. Col. K. M. Johnston of the Air Force's Quality Control Division (AMC), who witness first hand the urgency of the problem, are speaking and writing in order to accelerate improvement. The "Measurement Pinch" was given its broadest coverage by Beverly Smith, Washington Editor of the *Saturday Evening Post* who wrote a non-technical expose in that magazine and thus brought the cause within the purview of the public.

National Bureau of Standards is Focal Point

Quite naturally, the first place to turn when measurements, standards or calibrations are involved is the National Bureau of Standards which, by act of Congress, is charged with the responsibility of establishing and maintaining the primary standards of physical measurement in the United States. The Bureau's 1600 scientists and engineers and equal number of skilled mechanics and technicians conduct a broad research program to advance the science of measurement. The National Bureau of Standards provides the United States with leadership in the development of accurate and uniform techniques of measurement. It strives to stay ahead of the measurement requirements of science and technology. It provides the basis for the national measurement system. It must develop and maintain national standards to meet existing or anticipated needs. NBS must furnish essential services to promote accuracy and uniformity of measurements such as the calibration of instruments to the national standards, the development of transfer standards and standard instruments, the broadcasting of radio signals of standard frequency, and of course research and development on measuring processes and instrumentation.

Unfortunately, the total Bureau program in these areas is not sufficient to meet the tremendous demand for its services, which, over the past few years, has grown completely out of proportion to the staff, facilities and dollars available.

In addition to those activities that would directly serve to further the state-of-the-art in measurement, the Bureau must share its budget dollar with many other important functions. For example, it must cooperate with the states in securing uniform weights-and-measures inspection and enforcement. It must work with other organizations in the development of standard codes and specifications and cooperate with other nations to insure the compatibility of our measurement system with theirs. Also, the Bureau must provide data on the properties of matter and materials which are important to science, industry and commerce, and which is not available in sufficient accuracy elsewhere.

NBS Implements a Plan

Dr. Allen V. Astin, director of the National Bureau of Standards, points out that the Bureau is seeking to meet the present critical situation in three ways—by enlarging and strengthening its own calibration services program, by encouraging industry to undertake improved calibration services within particular areas, and by developing greater cooperation between government and industry in defining and attacking the most important of these problems.

In the latter part of 1960, an NBS Advisory Committee on Calibration and Measurement Services was named by Dr. Astin. It will be the duty of this group to keep the Bureau abreast of trends and conditions in industry. This information will help in determining priorities of the many projects on the Bureau's schedule. It will also point out measurement areas where mere juggling of priorities is not enough—areas where provisions must be made to increase the scope of calibration and measurement services available from the Bureau.

A modern and vastly improved facility is being built by the Bureau of Standards at Gathersburg, Md. At this new location it will be possible for the Bureau to offer many new services such as the calibration of devices in both tension and compression up to one million pounds. This additional capability will greatly accelerate the extension of modern force-measuring methods. Force measurements are widely used in industrial fields such as weighing, materials testing, automatic control of machinery, and rocket development. Consider further the Bureau's program in pressure measurements in which it will develop absolute pressures in the vacuum range. High-vacuum pressures correspond to the pressures encountered by missiles and space vehicles in flights to altitudes of many miles above the earth's surface.

Action Is Taken by Industry

Industry has not stood idly by in this crisis but has taken active steps to goad the giant of metrology into full stride. Within more and more companies we see a tendency to increase funding for facilities required to develop new techniques in calibration and measurement—even the inception of long-range programs for measurement research. We see a closer liaison between calibration activities and research and development. Participation in technical meetings on measurements is growing. Companies are financing further education in the related fields.

The Quality Control Committee of the AIA did not stop in its quest to better the measurement capabilities of the nation at the completion of its now famous survey. Again with the Sperry Gyroscope Company as project sponsor, it is coordinating industry participation

in a program conducted jointly with the National Bureau of Standards known as the Measurement Research Conferences. These are a series of meetings between industry measurement specialists and the Bureau experts. Together they probe the exact nature of certain measurement problems being encountered. Typical of one of the general problems uncovered at these meetings is that the weight and complexity of equipment is often increased due to the need for overdesign to compensate for measurement uncertainties in the design of the equipment. Another general problem is that involving resolution of measurement discrepancies which occur during the design and development of equipment. For example, the low confidence level for the accuracy of many types of measurements and tests makes it difficult to determine whether the cause of the discrepancies occurs in the equipment being tested or in the instruments with which the tests are being made. All of these things cost money, cause schedule delays, and deteriorate quality, reliability, and maintainability of components and systems.

Topics which have been discussed thus far at Measurement Research Conferences are: microwave power and attenuation, internal diameters, surface flatness and finish, gear measurements, infrared, temperatures, humidity, pulsed signals, sinewave radio frequency signals, and microwave noise measurements and calibrations. These meetings are producing excellent results in the form of recommendations for courses of action for NBS, industry and others which will result in long range as well as interim solutions to meet these needs. Meetings have been scheduled on other critical categories of measurement throughout 1961, with additional laboratory facilities added to support the activities of the expanded work force.

The Military Intensifies Their Activities

The military branches have been particularly affected by the slumber of metrology and they too have been active in changing the situation. They are training their own people, engineers and technicians, in the basics of the subject as well as in calibration procedures and other related topics. Increased weight is being given to calibration and standards in military quality control programs. In particular they are evaluating contractors on the points of traceability of their standards to NBS, frequency of calibrating their test equipment, procedures used, and accuracy ratio in going from one calibration level to another. The Air Force surveyed its facilities recently and found available a surplus heavy-press plant near Newark, Ohio. This has a concrete pit 200 feet long, 60 feet wide and 60 feet deep. There are approximately 25,000 tons of reinforced concrete in this pit. It is presently being modified into the Air Force calibration laboratory and will be known as "Heath Annex" at Dayton Air Force Depot. This is a "concrete" example of USAF's determination to improve calibration in that Service.

The Navy Bureau of Weapons recognized the general lack of standardized measurements throughout the country and initiated the SLIM program (Standards Laboratory Information Manual); officially designated as the Bureau of Weapons Calibration Program. The mission of the program is to insure the maintenance of accuracy, within design limits, of all testing and measuring systems employed in the Bureau of Weapons. This same program is also used by the Bureau of Ships.

A suggestion for the formation of an Association of Standards Laboratories has been made by Harvey W. Lance of the Boulder Laboratories, NBS. There is tremendous response to this idea since Mr. Lance pointed out that such an organization could competently make great headway in solving measurement problems that both the military and industry are looking to the National Bureau of Standards to solve. First steps have already been taken towards making this association a reality.

New Center for Measurement Science

An important long-range action taken to rouse the giant of metrology is the combined venture between industry, the government and the George Washington University of Washington, D.C., to get the youth of America interested in metrology and provide them with specialized education to pursue it as a career. This noteworthy undertaking is known as the Center for Measurement Science and is operated by the University's School of Engineering. It was established in September 1960, with the collaboration of the National Bureau of Standards, and a financial boost from the Martin Company, Baltimore, Md., which has been the prime industry spark plug behind this idea. A group comprised of those interested in furthering the measurement science have agreed to support the Center by contributions of $5,000 minimum annually. Three valuable accomplishments are realized from the generosity of the Associates of the Center for Measurement Science as they are known: the Research Program includes research and development work related to measurements undertaken as independent studies by staff members of the Center or by personnel of Associates; the Service Program provides consultation and assistance of faculty, staff and facilities of the Center on specific problems in measurement; and the Education Program which offers a course leading to an Engineering Technologist Certificate and the degree of Bachelor of Science in Engineering as well as Master and Doctor of Science degrees.

There can be no doubt that metrology is staging a comeback in the sciences. Those of us who have seen first-hand the frustration, chaos and tremendous expense caused by the inability to measure accurately to extreme tolerances sincerely hope that the country will never turn its back on metrology again.

The document which spearheaded awareness to the metrology problem is the Industry Calibration Survey. This is an extremely useful reference since it can serve not only as a market forecast for manufacturers of measurement equipment, but also can aid design engineers in determining which tolerances are within the state-of-the-art. Quality Control people will find it a handy tabulation of the calibration services available from the National Bureau of Standards in addition to being a categorized compilation of helpful measurement information.

A limited supply of copies of this survey report are avaliable at Sperry. Until the supply of existing copies is exhausted they can be obtained on request, but there are no plans for reprinting additional copies. Requests should be sent to: Harry Martin—(2T120), Reliability and Quality Control Communications Coordinator, Sperry Gyroscope Co., Great Neck, N.Y.

Cumulative Sum Charts

and their application to the chemical industry

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The chemical industry is confronted with many processes which are characterized by having high variability and frequent shifts in the process levels.

The purpose of this article is to present a new statistical quality control approach—involving new concepts in statistical analysis. This new approach centers around the use of the *cumulative sum* or *CS chart.*[11] These charts allow more optimum solutions than present charting techniques in the study and control of certain types of industrial systems.

In discussing CS charts, two major advantages will be stressed:

1) Quicker detection power when a true shift from control occurs in control procedures.
2) The ability to use a look-and-see approach that allows the application of graphical estimation techniques.

Several years ago Page[9] devised a new charting technique labeled "Cumulative Sum Charts" and he presented general rules for construction and application of decision procedures. His concept was based on the use of runs to increase charting sensitivity by combining information from the current sample with that of previous samples. He pointed out the fact that this idea attains its ultimate in cumulative sums. Proper use of CS charts, indeed, allows a look-and-see approach whereby one can note at a glance not only the value of the last observation but also the relations of the last three, four or let's say the last k observations.

Barnard[2] has further advanced the theory of statistical process control utilizing this general concept. Barnard's idea was to consider a system as a stochastic process and then apply the CS charting procedure to such systems. In this discussion of stochastic processes and their relation to cumulative sum charts, Barnard considered the factor of estimation rather than just hypothesis testing. Actual practical application has shown that cumulative sums possessed a rather phenomenal amount of graphical estimation power when they are plotted as CS charts. This was pointed out by Truax[1] in a recent anonymous article where the graphical impact of CS charts was labeled as a "look-and-see" approach to process study and control.

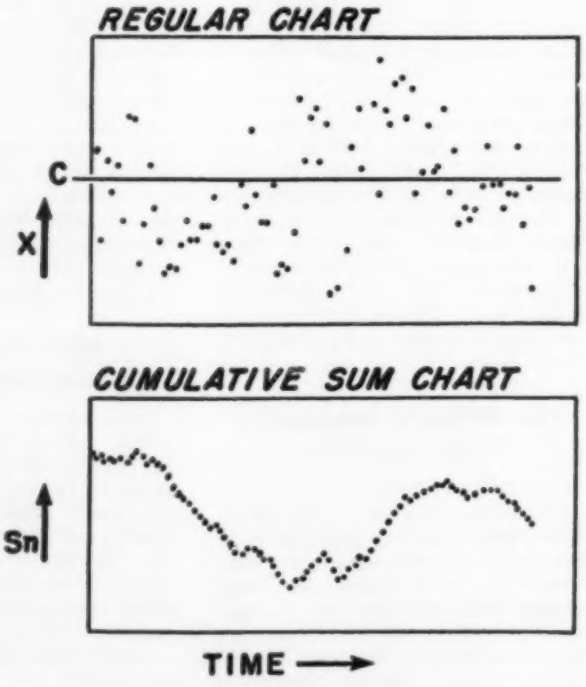

Figure 1

ASQC LCS Code 111;323:60;70:428

Since this is an introduction to CS techniques, the basic idea of control procedures will be considered and then graphical estimation procedures resulting from the CS techniques will be presented.

While many of the mathematical solutions concerned with the application of CS techniques to control procedures have not yet been completely constructed, cumulative sum charts offer an immediate advantage based on the look-and-see approach to control and estimation procedures. Certainly one of the most persuasive points in favor of CS charts is quite readily apparent when the same data are plotted both by regular techniques and by CS techniques. Typical process data from an actual chemical system is shown in Fig. 1. Without any information as to the underlying concept behind CS charts, it is intuitively evident that CS charts present a clearer picture of the true system behavior. Points at which process changes occur stand out vividly on the CS chart, however, such changes are largely hidden when using conventional charting techniques. Evaluation of process shift magnitude from CS charts depends on ability to estimate slopes, thus practical use of CS charts requires further explanation.

This new concept of CS charts is aimed at tighter process control by faster detection and correction of small process deviation from control. This concept also allows more accurate accounts of real changes in process levels relative to the behavior of the overall system. Simply, the CS chart is a running summation of process deviation from some preselected control or reference point. It resolves the shotgun or scattered appearance of the regular control chart into a visual tracking of process changes. Graphically, it cuts out the random noise (inherent variability such as sampling measurement and the like) in the system. Simultaneously, it magnifies the real systematic changes in the system. The net effect is literally a look-and-see approach to process study and control.

It will be generally assumed that the data (the x measurements) can be plotted as equally spaced points (either as samples from a continuous time variable or as discrete samples) and are independently distributed as N (μ_j, σ^2) where σ^2 represents the "noise" of a system. The primary interest is detection or estimation of location parameter shifts.

It should be pointed out that while benefits from CS techniques are suggested for certain systems, general recommendations of wholesale replacement of regular control charts are not proposed. Certain observed limitations of CS procedures will be pointed out in the main discussion.

Process Control

When one considers the basic reasoning behind control charts, it must be realized that the most important general characteristic of any control chart is the average run length scheme[9,10] associated with the control plan. When the true process level remains constant, the average run length L_λ of the scheme is the expected number of samples recorded before action is indicated when the process is at some constant level λ ; $\lambda = (\mu - \mu_0)/\sigma$. Here μ_0 is the refererence, or control point, and μ the true process level. Thus L_0 is a special case in which the process is operating at μ_0, the control point. The criteria for the selection of one control scheme over another should be

$$[\text{Min. } L_\lambda \text{ for fixed } L_0] \qquad (1)$$

L_0 and L_λ are functionally related to the usual Type I and Type II error, however, in such schemes as cumulative sums the functional form would become quite complicated. In some instances the desired criteria might be [Max. L_0 for fixed L_λ]. However, this can be considered merely a dual of (1).

In earlier articles, some of the sufficient conditions surrounding the use of CS charts have been presented by Page. It has been shown by Page[12] that utilizing basic concepts, one can map regular control chart concepts into a CS charting procedure. His mapping of particular control charting techniques into a cumulative sum is quite interesting, since it gives a real insight into the fact that CS charting is not a radically new idea but rather a logical extension of Shewhart control chart techniques.

The formation of cumulative sums from control data is indeed simple. In contrast, the mathematical solutions associated with CS control procedures are quite complicated. Mathematically, cumulative sums may be represented as a random walk with one or two absorbing barriers.

The cumulative sum, S_n, is obtained from the original x data by forming,

$$S_n = \sum_{i=1}^{n} (x_i - k) \qquad (2)$$

where k is some constant dictated by the particular control procedure that has been selected.

For the one-sided tests $k = (\mu_0 + \mu_1)/2$, where μ_1 is the desired rejection level and μ_0 is the control point. Assuming that no action has been indicated since x_0 and the system has been operating at some level μ_j, the action rule for this CS scheme is,

$$S_n - \underset{0 \leq i < n}{\text{Min. }} S_i \leqq h \qquad (3)$$

where h is a constant that is determined by k and the restrictions on L_0 and L_1. Thus, when (S_n — Min. S_i) equals or exceeds h, action is taken on the system. After a violation of the action rule at the r-th point the rule may be reapplied by considering a new index $i' = i - r$ such that points prior to r are not considered in future tests.

In general, application of graphical procedures is simple. The points (S_n, n) can be plotted on a CS chart just as a regular chart of points (x_n, n) is plotted. Now in Fig. 2 the decision rule can be applied by means of a special mask that is constructed with a vertical distance of h units. This mask may be applied by placing the upper right corner of the mask on the last point, S_n. The action condition, h, will only be satisfied when (Min. S_i) either touches or falls behind the lower edge of the mask. Graphically a new index i' can be established relative to the action condition h merely by disregarding all points prior to the last action point when the mask is applied. In Fig. 2, the circled point represents the last action rule violation. Ewan and Kemp[5] have discussed this one-sided test and have prepared tables and formulas related to these schemes. They also present an alternate method of plotting which is more desirable for actual use of one-sided test procedures. Tables for fraction defective schemes have also been prepared by Page.

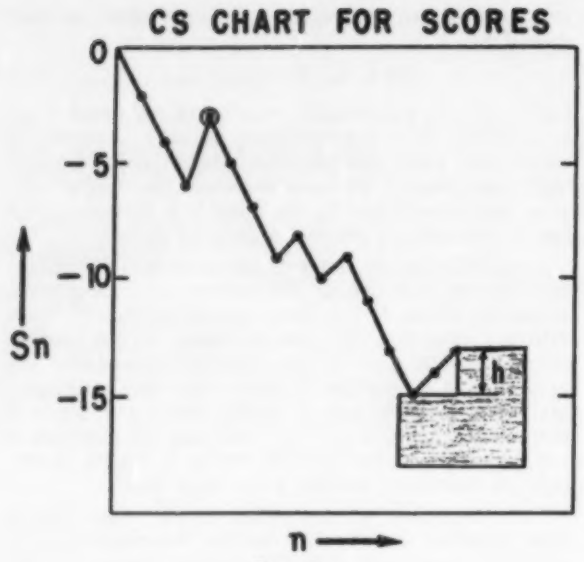

Figure 2

The two-sided CS test represents a far more important case in processing industries since many charting procedures involve properties that require two-sided control.

In this case S_n is defined as,

$$S_n = \sum_{i=1}^{n} (x_i - k); \; k = \mu_0. \qquad (4)$$

The graphical application of this two-sided test action is now based on a V-shaped mask. The vertex of the V points horizontally forward when placed on the chart. Note in Fig. 3 that there is a horizontal distance d which has not been cut from the mask. Therefore, the important parameters of this mask are the distance d and the slope tan θ. The point 0 of the mask is placed at the last cumulative sum, S_n, and past data are reviewed. As with earlier masks no action is taken if all points since the last action point ($i = 0$) are visible. The action signal results when some S_i ($0 \leq i < n$) in this interval touches or falls behind the mask.

In practice, masks should be constructed by two techniques. One solution requires a "cut-and-try" approach whereby d and tan θ are selected by analysis of past CS charts. The other requires approximate solutions of the random walk with absorbing barriers on the edge of the V. These solutions allow the determination of d and tan θ based on fixing L_0, L_1, plus the magnitude of process shift that must be detected. Goldsmith and Whitfield[7] present charts for use in the selection of d and tan θ, and show that the run lengths of these CS procedures are not adversely affected by first-order serial correlations except for values near ± 1. Since experience has indicated that samples from many continuous industrial systems do exhibit some degree of serial correlation, their findings present additional weight in favor of CS techniques.

Prior to actual application of V masks, considerable past data in CS form is reviewed. CS charts are first reviewed by a process engineer who has been intimately concerned with the particular system. The CS charts are marked with known changes in input variables and general comments regarding finished product acceptability. He is instructed to develop a mask such that during periods that satisfactory product was produced (based on existing standards) the mask will not signal action, i.e., all points remain with the truncated V. Then during periods when finished product is known to be unsatisfactory the mask should be so fashioned to signal action as quickly as possible. An actual example is shown in Fig. 4, where the mask denoted by the dotted lines represent the "cut-and-try" form selected by the engineer.

Also, a mask based on the Goldsmith-Whitfield tables is constructed. This mask is based on selecting an L_λ in the range 3-6 for some predetermined magnitude of shift, λ, from control which is deemed important. The average run length for the plan when the system is at control must be maintained at some high level, usually greater than 300. Such a selection was made in Fig. 4 where this solution is shown

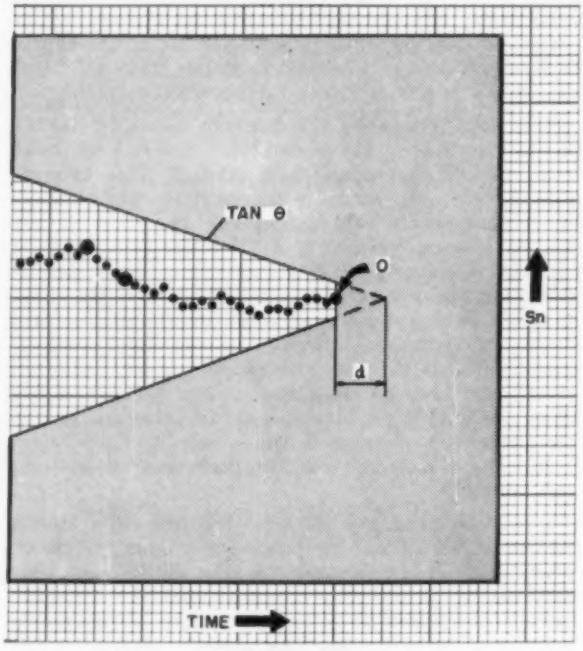

Figure 3

as solid lines. The good agreement between the "cut-and-try" procedure and the mathematical solution exhibited in this example is typical of the situations noted in our application of CS control procedures.

The main purpose of CS control procedures has been quicker detection of important process shifts. In this CS example, L_0 was selected to correspond to the same L as the previous Shewhart control chart[13] with limits at $\pm 3\sigma$. Figure 5 shows the ARL functions for the two schemes. This chart clearly shows that the CS procedure is uniformly more powerful over the important range ($0 < \lambda < 3$). Interestingly, when $\lambda < 3$ the CS procedure is less powerful. However, in this range L_λ is usually less than 2—and the differences in average run length characteristics in this range would be trivial in most schemes.

After the final selection of the mask, CS charts of existing data are again reviewed by the plant quality control department. Comparisons of extended amounts of data before and after application of CS

control procedures has visually reflected the greater improvement in detection power than has been suggested by the ARL curves in Fig. 5.

In some cases these CS techniques have actually been set up in the process control room. The operator responsible for the system actually plots response data and makes decisions relative to process control based on the use of a V mask. Drafting machines are used to insure that the V mask remains horizontal when moved about on the CS charts. Thus the operator is insured of a "straight-forward" charting procedure which merely requires his plotting points and moving the drafting machine to the desired location. Such applications have been very well received by the operators since, compared with regular charts, the CS charts have supplied additional information to the operator. He can now visually review past data from the chart and develop a better feel for the process system. This additional information comes from the fact that the CS charts have a considerable amount of visual estimation power built into them.

This estimation ability was also noted by quality control engineers during the initial CS studies of systems prior to developing CS control procedures. This fact has led to the "look-and-see" approach to process study and control. Such an approach is based on the visual estimation power of properly constructed CS charts.

Plotting Techniques

Due to the nature of cumulative sums, their plotting as CS charts require special considerations which are not needed with regular control charting.

CS charting techniques can be discussed from a general viewpoint such that CS charts can perhaps be used not only with control procedures but also as estimation procedures. As the charting techniques are presented, indeed it will become apparent that CS charts do possess some unique estimation properties.

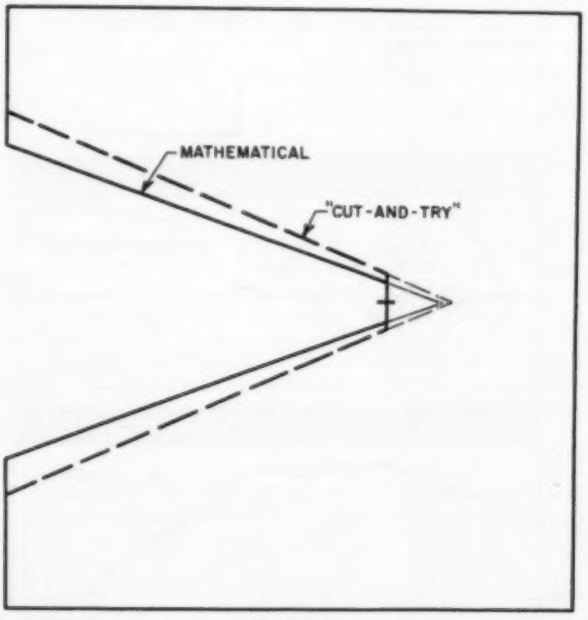

Figure 4

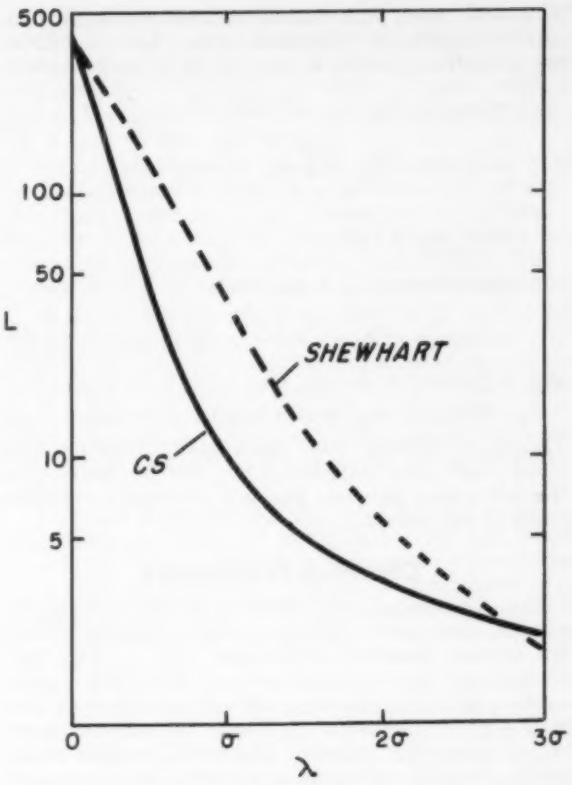

Figure 5

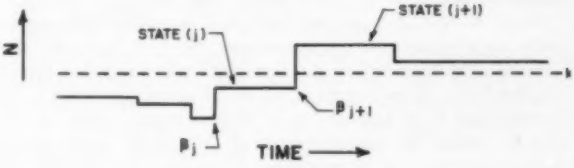

Figure 6

The cumulative sum can be more generally defined as:

$$S_{nj} = \sum_{i=1}^{n} (z_{ij} - k) \qquad (5)$$

Here the j index represents the state of a system and the i index indicates the location of the sample within a particular state. An example of a continuous process that behaves in such a manner is shown in Fig. 6. Let the time location at which the j-th state occurs be denoted by β_j. The z's are assumed to have an independent normal distribution,

$$f\ (z_{ij} |\ \mu_j)$$

such that

$$E(z_{ij}) = \mu_j,$$

and

$$E(S_{nj}) = E\left[\sum_{i=1}^{n}(z_{ij}-k)\right]$$

$$= \sum_{i=1}^{n} E(z_{ij}-k) = n(\mu_j-k) = n\lambda_j. \qquad (6)$$

Therefore, when the process level in a particular state is different from some constant, k, the CS points should tend to exhibit a slope of approximately λ_j; the true process level difference from k.

For a particular j-th state, consider some subset of r ($r<n$) consecutive samples where the sample

data have been recorded as cumulative sums. This subset, in terms of cumulative sums, has the following properties relative to estimation of the parameter μ_j

$$S_r = S_{t+r} - S_t$$

$$= \sum_{i=1}^{t+r} (z_{ij} - k) - \sum_{i=1}^{t} (z_{ij} - k)$$

$$= \sum_{i=t+1}^{t+r} (z_{ij} - k). \qquad (7)$$

substituting $i' = i - t$ results in

$$S_r = \sum_{i'=1}^{r} (z_{i'j} - k) \qquad (8)$$

and it follows from (6) that

$$E(S_r) = r\lambda_j, \text{ which implies } S_r/r \to \lambda_j. \qquad (9)$$

Therefore, subsets could be visually selected from a CS chart and estimates of λ_j can be made from the difference between the two extreme cumulative sums of the subset.

Charting Techniques

For the control procedures that have been discussed, obviously, cumulative sums must be plotted by certain charting techniques. Due to the basic differences and characteristics of cumulative sums, certain additional precautions are necessary in plotting CS charts which are quite different from the usual procedures followed in plotting regular charts. After forming the cumulative sums, S_n, the coordinates of the system are (S_n, n) and each of the n sample points is plotted along the vertical S_n axis.

Now n equally spaced points along the horizontal time axis create a displacement on the vertical CS axis of approximately $n\lambda$, whereas on a regular chart the vertical displacement is only of magnitude λ. It is obvious that the scale of the vertical axis on CS charts must be compressed if in actual practice a large number of points are expected to remain on the chart. This is important for the control procedures that have been discussed, since it is desirable to manipulate the mask about the chart and then be able to review past process data as a continuous series of points. Poor selection of charting scale factor will result in the points disappearing off the chart area or—at the other extreme—compressing the slopes to such a degree that the points cannot be accurately plotted.

To minimize this problem a scale factor of approximately 2 to 3 sigma per observation has been found to give very satisfactory results permitting the CS data to remain on the chart. When applying this particular scale factor to a control procedure, it has been found that 11 × 17 inch chart paper with 10 divisions per inch results in a very satisfactory form for applying mask procedures. The combination of this size chart paper and scale factor is a happy compromise that allows sufficient detail for plotting the points plus sufficient compaction to permit the points to remain within the charting area.

While such information supplies the control engineer with the desired information with respect to establishing control procedures, a far more interesting facet of cumulative sums becomes evident to the engineer observing past process data plotted in this manner. This additional information corresponds to the visual impact that has been observed by the operator on the system when using CS control procedures. This scale factor of 2 to 3 sigma per observation has compressed most of the relative system noise between the points into a zone of plus or minus one unit on the vertical axis, yet visually does not seriously affect the magnification factor resulting from the slope λ of the true process shift. Thus, when a series of such points are reviewed on a CS chart, they tend to form a line during a particular system state. The slope of the line formed by these points estimates the true slope λ. Such a feature of CS charts leads one to consider their use as a visual estimation concept. In control procedures, the important characteristic is the proper perspective of CS points so that the desired control mask can be applied. However, when the "look-and-see" approach is of primary interest, then other graph paper procedures can be more desirable. It has been found that graph paper of 20 divisions to the inch represents the best charting procedures when evaluating CS charts as a "look-and-see" approach. From a visual point of view this paper compresses the system noise to a very small visual area, yet still allows the proper visual impact to the slope magnification. It permits the engineer to observe the slope of a particular process state just by looking at the cumulative sum plot. This enables the engineer to apply a valuable new technique in studying point of process shift and magnitude of process shift change.

Observation of the "look-and-see" approach versus regular charting procedures is important in portraying the great advantage realized in application of the CS technique to past system data. This example is shown in Fig. 7.

Random normal deviates[4] with distribution N (0, 4) were sampled from tables. The first points have an input of $+1\sigma$, the second 20 an input of 0, and the third 20 an input of -2σ. These inputs are analogous to changes in process levels of an industrial system. Figure 7 represents a typical picture that was exhibited when 25 such sets of data were plotted on CS charts. The regular control chart, with 3σ

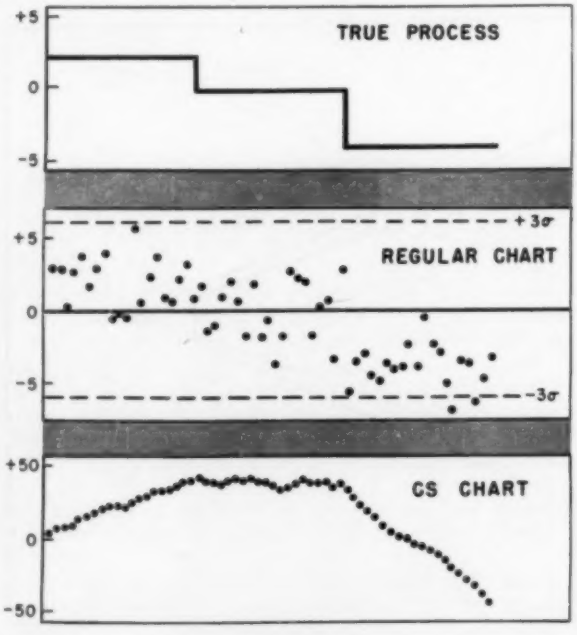

Figure 7

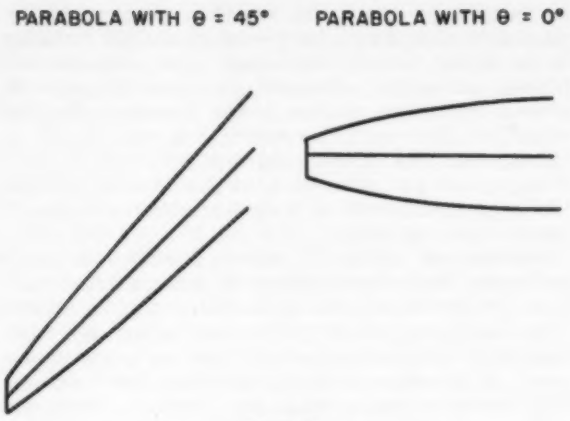

Figure 8

limits centered about zero, is shown first. It supplies a minimum of information and does not readily lend itself to estimation of process shifts.

Now consider the CS chart. Due to the proper selection of scale factor the cumulative sum is restricted to a reasonable area, yet the three different process levels now become distinct. The process noise has been largely masked, resulting in a visual tracking of the true system level. When the process is operating above control the points form a positive slope, when on control the points form a nearly horizontal pattern, and when below control they create a negative slope illusion.

Assume the data shown in Fig. 7 represented process data and that neither magnitudes nor time locations of process shifts were known. It is now apparent that estimates of both process properties can be made from the CS chart. This example indicates that time location estimates of process shifts are quite precise when data is CS plotted. Indeed the 25 sets of random deviates show that the CS chart has excellent detection power relative to point of process shift.

Estimation Techniques

Since, in practice, it has been noted that one of the primary values of the CS chart is as an estimation procedure, a discussion of general graphical estimation procedures seems important at this point.

A blunted parabola form was originally suggested for estimation purposes.[2] It has been proposed that such a parabola prepared from "cut-and-try" considerations be moved about from S_t such that a maximum number of points be visible and the relative slope corresponding to the process state would be estimated by the slope of focal axis of this parabola.

In practice, some blunted parabolas have been studied in estimation problems. Applying the initial assumption and allowing the existence of a particular process state, a parabola can be constructed based on the cumulative function equation. Then it follows[3] that,

$$\text{Var } (S_{nj}) = n\sigma^2. \qquad (10)$$

Therefore, when considering CS points adjacent to say S_1 (either forward or backward along the axis) it can be shown that a point S_n relative to S_1 has limits,

$$S_n = n\lambda \pm U_p \sqrt{n}\,\sigma \qquad (11)$$

where U_p represents the two-sided fractiles on the normal distribution in relation to some probability level p. Such an expression can graphically be represented on a CS chart as a continuous parabola that satisfies the conditions of (11) at each discrete point. The parabola may be blunted by replacing n by n + 1 on the right side of (11).

Several problems in applying such parabolas have been discovered. First of all, due to the form of (11), the shape of the parabola is dependent on the magnitude of λ. As λ increases in size, the parabola becomes visually smaller relative to a CS chart. This is shown in Fig. 8, where tan θ is proportionate to λ.

However, a more important facet of CS techniques becomes evident when studying such parabolas relative to CS charts prepared from random normal deviates having N $(0, \sigma^2)$. Applications of the resulting parabolas invariably have shown that the p probability bounds have consistently appeared too broad relative to the actual behavior of the graphed CS points.

A plausible explanation for this observed phenomena has been discussed by Feller.[8] He points out that a sequence of cumulative sums, for a particular μ_j, is likely to contain a surprisingly small number of changes of sign relative to λ_j. This is a consequence of the arc sine law[6] that was first discovered in connection with Brownian movement and random walks. This extension of the arc sine law suggests the presence of additional visual estimation power when evaluating CS charts. Properly constructed CS charts have also shown excellent resolution power with respect to detection to process shift location. The visual power of such location shifts is dependent on the magnitude of the change in process levels relative to the reference value k.

Therefore, a simple "look-and-see" approach has been adopted whereby visually one detects the points at which state shifts have occurred based solely on the observation that a "true" change in one true slope, λ, has occurred.

In the study of process data, two important process properties are important, the point of change be-

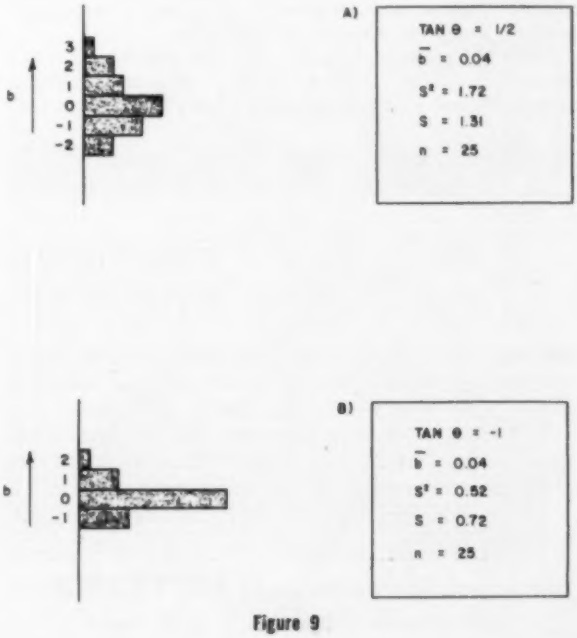

Figure 9

tween two states, and the magnitude of change between the states. The point of process change can be estimated from a CS chart by visually locating the point at which a change of slope has occurred on the chart. Initially, process studies with CS charts of output variables showed that points of slope changes could be closely related to periods of changes in level of input variables. This factor suggested the sensitivity of CS charts to detecting point of output process change.

Since estimation procedures depend to a large degree on being able to segregate states so that valid state estimates can be made, location of point of change obviously has considerable importance. Random normal deviates from the previous study were evaluated in order to more closely obtain some feel for the detection of point of process shift through the use of CS charting techniques. The initial results of this study are shown in Fig. 9. Histograms and statistical estimates are presented.

These results suggest the sensitivity in estimation of the β_j, the true time of process shift. The results are reported as deviations from the β's. The b estimates were determined by observers unfamiliar with the true location of the β's. Figure 9 suggests that relative detection power of shifts from zero slope may be symmetrically distributed with variance approximately related to

$$\text{Var (b)} = \tfrac{1}{2} (\tan \theta)^2.$$

While further sampling studies are necessary, such factors in their crude state suggest the "goodness" of CS techniques in estimating the β. While this table indicates the sensitivity of CS charts to point of process shift, geometrical considerations must also be evaluated when reviewing the merits of CS techniques.

Figure 9 has suggested that estimates of the λ's may be biased, since in practice the true β cannot be exactly determined. More conservative estimates of λ could be determined by deleting several points adjacent to b and base the estimate of the results of equations (7-9). It can be seen that CS charts do offer estimation benefits, and the purpose of this section is to point out areas that empirically seem important and that require further study.

In many industrial applications an important facet of process study is the estimation of points in time at which real shifts of process states have occurred.

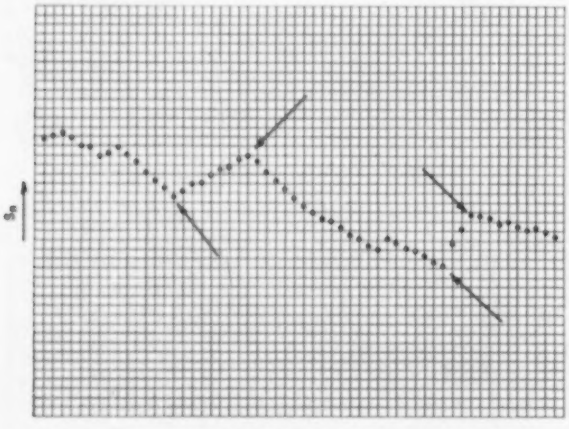

Figure 10

In many cases the input variables responsible for some of the changes in process states are not included in the initial list of "important" input variables affecting the system. Reliable estimates of point of process shift have resulted in the discovery of input variables that were heretofore not considered of consequence. By pinpointing the location of these changes, one can refer back to past process records and evaluate changes in input variables corresponding to these periods.

An example in Fig. 10 shows an output plot on a particular batch-type industrial process. A batch-type process is considered so that it can be clearly appreciated that CS techniques may be just as readily adaptable to batch processes as they are to continuous ones. In the example, points at which "real" process shifts occurred are noted on the CS chart. Then past process records were scrutinized for information regarding input variable changes that might be related to the points at which the output variable suggested slope changes. In this particular example the CS chart of one output variable permitted the identification of a particular input variable that was not previously considered important. Realization of the importance of this additional input variable permitted its inclusion in the operating procedure so that no future output variation would be expected from that variable.

While the previous example indicated the importance in estimation of location points *per se*, there are other extremes where the exact magnitude of process shift is the governing factor. In another chemical operation the important control variable was previously measured by a chemical measurement, y. The determination of the y values required considerable time and the method was plagued with large analytical variations. A new method that was both rapid and precise was developed. However, it was realized that this new method was dependent on certain raw material properties which were known to change infrequently. The relation of the two methods was found to be of the form:

$$\hat{y} = b_0 + b_1 x$$

where b_1 remained constant but b_0 was constant only within certain periods due to the nature of the raw material properties. It was decided to control the process with the x measurements but to routinely check the regression equation. Then when "significant" changes were detected in the value of b_0, a correction could be made in the control procedure so that x would properly control the property y. Such a check was easily carried out by use of a CS chart. The cumulative sum was based on the difference between the actual determination, $\hat{y}$, and the estimate, y, that was based on the regression estimate from the x values. Now, as long as the b_0 term is correct, the CS chart of the differences would tend to form a horizontal pattern. When the raw material characteristics shift, the resulting CS slope estimate indicates the best estimate of the change in b_0. This type of application suggests a more general application of CS charts in cases where differences between two measurements such as machines, methods and the like are of interest.

So far only situations where location parameter shifts are of importance have been considered. In general, any z variable having additive properties may be evaluated as a cumulative sum. When the

variability of a system is of prime importance, it has been found that a cumulative sum of the absolute differences between successive observations is most effective. The differences between successive observations are treated as follows,

$$S_n = \sum_{i=1}^{n} (R_i - k) \quad R_i = |z_i - z_{i+1}| \qquad (12)$$

CS charts constructed on this basis have resulted in the detection of important changes in variation within a particular system. It should be clear that other variables (or transformed variables) can be evaluated by the "look-and-see" procedure.

The important point to be realized is that this concept must be tried to be appreciated. Until an individual actually attempts the application of such concepts to his own data (and perhaps to random normal deviates), it is difficult for him to realize the real value of cumulative sums in his applications.

Conclusion

While cumulative sum techniques offer a new tool to the quality control engineer, it must be stressed that there are no recommendations of wholesale replacement of regular charting techniques. Cumulative Sums must be evaluated and used with caution by the CS beginner.

Since CS technology is still very new, many theoretical aspects must still be investigated before one can make general statements regarding such factors as robustness. For example, it is noted that tables for constructing CS control procedures are currently limited to binomial cases and normal deviates with constant variance. While perhaps some variables can be transformed so as to be approximately normal, present sampling has not been carried this far. The effect of changes in degree of process noise relative to a test on location parameter is also open to question. As CS applications spread, such questions can be expected to be resolved. The available information on insensitivity of CS control systems to serial correlation is very encouraging, since many chemical type systems can be expected to exhibit some degree of correlation.

The general assumption related to claims regarding CS applications is that the data or system makes sudden shifts between states and within a state there exists some constant true location parameter, μ. CS techniques are not currently recommended in a case where gradual changes of a drifting nature occur. There are obviously other types of systems where these CS procedures might be inferior.

Visual impact of CS charts is limited, to a large degree, to the form stated above. This reason is rather simple — since cumulative sums can be considered as a stepwise integration of the true system form. If the process has a straight-line drift, a CS chart will be quadratic in nature. Interpretation of curved lines is very difficult indeed.

The "look-and-see" aspects have shown striking results in many industrial applications, however, further sampling studies are needed to develop more rigorous rules in estimation techniques.

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He was born in 1898 in Buffalo, graduated from Cornell University in 1918 and took his doctorate at the University of Pittsburgh in 1931. He began his long career in the mathematics department of the Carnegie Institute of Technology in 1922. His research activity in his chosen field of mathematical statistics continued all his life, resulting in some 50 published papers. Many of these came from his critical study of statistical quality control.

He was active in the Institute of Mathematical Statistics from its founding, serving as its secretary in 1941-43, its vice-president in 1946, and president in 1954. He was perhaps the first teacher of mathematical statistics to become seriously interested in statistical quality control. His Pittsburgh group was the first of those that later became sections of the ASQC. He joined Holbrook Working very early in organizing and giving the series of some 30 eight-day courses during World War II that gave statistical quality control its real start in this country and led to the founding of the ASQC. He continued to participate in SQC short courses after the war; at his death he had taught in at least 75. He served the ASQC in many ways—as a member of important committees, as a speaker at many of its meetings and as a wise elder statesman. He was a recipient of both the Brumbaugh Award for 1953 and the Shewhart Medal for 1954. He was a Fellow of the ASQC, the Institute of Mathematical Statistics, and the American Statistical Association. Many companies sought his counsel as a consultant.

Despite his distinction as a scholar, he was first of all an extraordinary teacher. His clarity, forcefulness and humor gave the hundreds of his students, from those who took their doctorates under him to beginners in quality control, an experience they will always cherish. I consider him our greatest teacher of statistical quality control.

He made friends everywhere he went, in and out of his profession. His colleagues esteemed him for his critical mind, his high standards and his devotion to his work. Those who worked with him loved him for his warmth, his modesty, his sense of humor and his unfailing generosity. He was unique and irreplaceable.

Ann Arbor, Michigan
October 19, 1961

C. C. Craig

Human Relations Problems Encountered in Quality and Reliability Control

HERMAN KARLEBACH

Omark Industries, Inc., Portland, Oregon

IN ORDER to discuss the problems one would encounter under a Total Quality Control program, it will be necessary to classify these problems loosely under three general headings, organizational, technical, and cultural.

Types of Problems

Anthropologists and sociologists are people who study groups of people or cultures.

The anthropologists and sociologists claim that any technological change has two major components —the technical aspect and the social aspect.

To verify this fact, let's consider the impact of some technological change we have experienced such as the electric light, the telephone or the television set. I prefer the television as it is the most recent, and we are still experiencing the results of its impact on the American people.

Consider the technological advances — components, camera, transmission, etc. They are too numerous to mention. But more important, consider the increased employment, improved communication — all in the social aspect. We all have our own views on this particular point, and no doubt, controversial viewpoints, and each one has a definite merit.

The social aspect is one of the changes that is taking place. All of us in some way or another are opposing this change — but in the same breath, we, ourselves, are undergoing a social change.

Presented at 14th Annual ASQC Convention-Work Shop Clinic May, 1960, San Francisco, Calif.

ASQC LCS Code 310:60;70:400

If we consider a factory as a "culture,"* and this is no stretch of the imagination, we must consider this group of people — their way of thinking and acting under present conditions—and then consider what effects a technological change would have on this "culture." Certainly a quality control program would be a technological change.

Again, the technical aspect is not as important as the social aspect. It could be considered as nothing more than a misunderstanding of some new terminology, such as sigma, square root, mean, range, and so forth. Most significant, by far, would be the *resistance to change* that the quality control program would meet from the people.

We have now placed the factory in the position of a culture, and sociologists claim that any change that attempts to destroy a culture meets resistance to this change.

There is the problem: a culture (factory personnel thinking and acting) and a technological change that must alter the people's (in a culture) way of thinking and acting.

Bear this fact in mind, that any quality control program that does not take into consideration its effect on the people is almost sure to fail.

Who Experiences the Problem

Since we are about to provide a technological change and desire its acceptance, we must know who in our factory culture it will affect.

*Juran, J. M., "Cultural Patterns and Quality Control," *Industrial Quality Control*, Vol. XIV, No. 4, Oct. 1957, p. 8-13.

Inspection Personnel

I believe that the individual inspector is the one person who will receive the greatest impact.

Here we have an individual who makes an immediate evaluation of the defective part. With the implementation of a quality control program, he will no longer be concerned with the individual part, but with a frequency distribution of a single variable within a group. He will be gathering data for a long-range, semi-research-type project for a QC Fact Finding Committee rather than short-term reporting. He will be confronted with statistically-derived control limits of doubtful legitimacy on an $\bar{X}$ & R chart that often opposes the old legal and legitimate blueprint authority of it's "good" or it's "no good." He will see his most accurate measuring equipment being treated as one of the variables in a process evaluation instead of it being the "last word" in settling a debate with a production foreman. The most precise inspector will find his inspection procedure being compared to the less precise, but maybe more accurate, measuring techinque of a relatively new inspector.

This technological change does necessarily have to change the thinking and acting of the inspection group. If the sociologists are correct, we will meet resistance from the very people who will have to install this change.

Production Personnel

As this technical change diffuses into the production process, we find the production operator or technician being brought into the "act." He becomes more active in maintaining a control chart and probably due to his desire to do a good job he is told (very often

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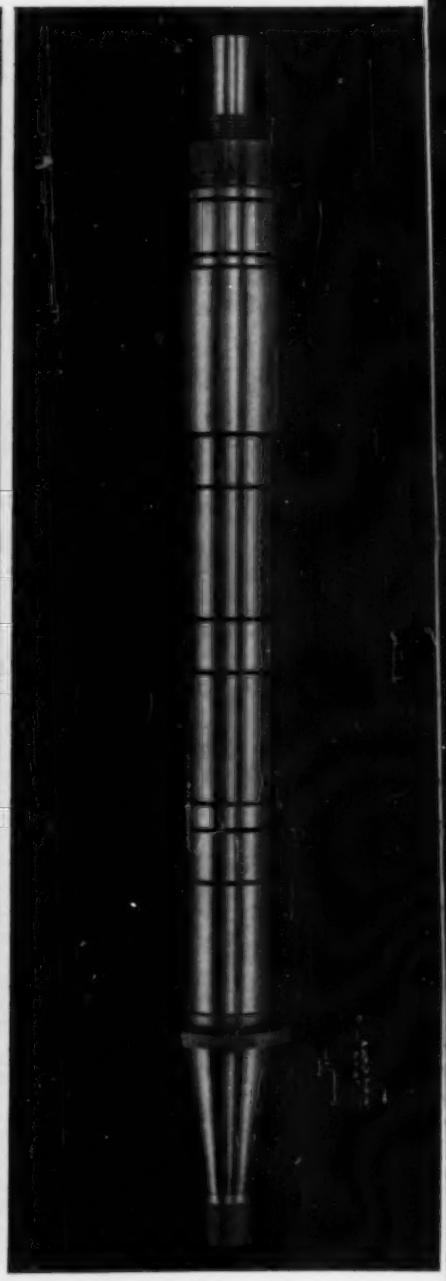

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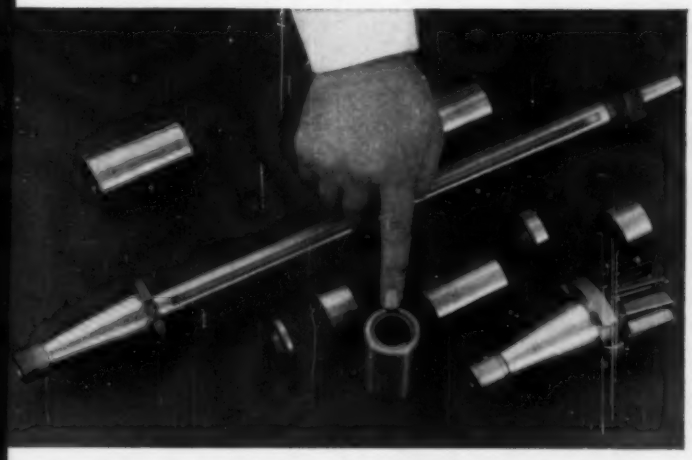

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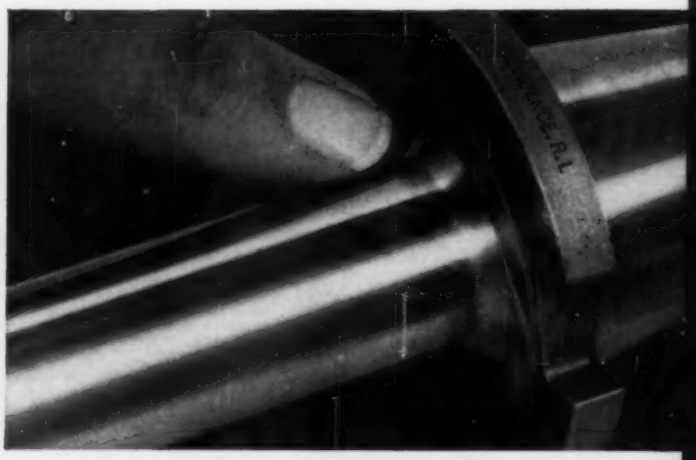

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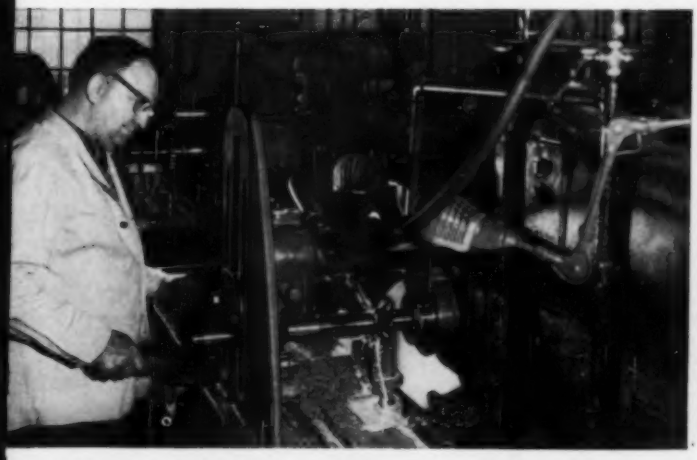

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in an undiplomatic manner) that he is showing "bias" in his sampling. This, as far as he is concerned, is an accusation, and he resents it. Like the inspector, he regards "control limits" as illegitimate criteria that he has to follow. Using these criteria he may have to accept a sample with a part that is out of tolerance, or even worse reject a sample where all the parts are to blueprint requirements.

He is on the horns of a dilemma. In contradiction to his former thinking of producing individual parts to legitimate blueprints, he now has to track down assignable causes of process variation as pointed out by a control chart with no official status, and something he doesn't even understand.

Now how about the production supervisor. Here is a man caught between two fires. On the one hand he must meet delivery schedules; on the other the parts produced must be quality parts. (Most production supervisors believe quality means *no* defects.) In addition to being a quality control agent, he has additional technical duties with the addition of control charts that he probably dislikes because they imply a criticism on his previous methods.

So we can see that again resistance to change would be there, maybe for a different reason than the inspection department personnel, but in a no less degree because the thinking and acting is being changed.

Engineering Department

This new concept of process capability, probability charts, analysis of variance, regression analysis will receive no open-door policy from engineers. After all, here is an individual who designs an item and mathematically computes the tolerance of a given dimension from his past knowledge of what is considered good engineering practice.

He is the former lawmaker. This new technological advance is literally challenging the authority of the lawmaker. Armed with a process capability chart QC shows him that a dimension cannot be held or oppositely that production can hold a tighter tolerance than he needs. Perhaps it might demonstrate that even after all these months — 25 percent of a component dimension was outside of what he assumed was a critical dimension.

Again, the social impact of a technological change is going to provide a resistance to this change since the thinking and acting has to undergo a change.

Reasons for the Problems

There are many reasons, but to be brief, let's list a few pertinent ones. Since "confession is good for the soul," let's perform a little self-evaluation.

1. The quality control engineer may wish to install control charts simply to show off his sophistication
2. He may be "sold" on some control technique whose application in the process would be more expensive than the value received
3. He may misuse a control chart in a situation where it is necessary to discover the reason for failure to meet specification by getting nothing more from it than statistically significant evidence of variation.
4. If a quality control program fails, we will have to look for the reasons from the production viewpoint before and after this program, not from the quality control engineer

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5. The control chart may be made to appear as an illegitimate instrument required by a department with no recognized legislative powers
6. The techniques (control charts, probability graphs, etc.), conflict with old systems and laws without repealing those laws
7. The techniques call for new patterns of action by users, different from past actions, without solving the new problems they bring to light
8. And last, but not least, the technological change conflicts with specifications and other methods of gathering data, and the operator or inspector has to resolve this conflict.

Possible Aids to Minimize Problems

If these things are true, or even partially important, then we must consider a solution.

There is no apt solution. What we can do is provide some suggestions on how to minimize this problem.

1. Secure active participation by soliciting the assistance of those people who will be affected by the new program during the initial planning and implementation and thereby create a favorable climate for the change
2. To do this it is often wise to reduce the surplus technical part of the new system
3. Select a small area where trouble, importance, and reception to new thinking is high. Try to reduce the impact of the change by persuasion rather than authority. Allow the new system sufficient time to spread its way into the broader thinking and acting in the shop
4. And, finally — at all times — try to place yourself in the other man's shoes.

Evaluation

With these aids in mind, let's go over the problems as experienced by the inspection personnel.

We bring the inspector in and explain our ideas to him; we persuade, rather than force him, to consider the ideas; we let him know of the problems he will face. We teach him new techniques of doing his job — sampling tables, $\overline{X}$ & R charts, etc. We start showing him his test equipment is good, but not the last word. We eventually persuade him to think along the same lines. We have him begin to gather data over a period of time, and slowly he begins to forget about an individual piece and begins to get a broader concept of the operation. He starts to think in terms of uniformity rather than acceptable or rejected. He commences to investigate past records and urges corrective action prior to defect occurrence; his thinking and acting begin to be those imposed on him by the cultural change we have instituted.

The production supervisor, like the inspector, is persuaded to try out a new idea. He is conditioned to the fact that nothing is perfect, but that he can have warning signals installed, that his process capability can be illustrated so that he can predict what and where he is and be able to prove this. He can know just how much scrap would be generated by an increase in production or a change

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in the process. As he begins to understand that this new change will be proof of what he has been telling management all these years, he will slowly withdraw his opposition. As familiarity with its use increases, his enthusiasm spreads to his employees — they begin to rely on the charts; they forget about specifications and begin to use reject limits and forget about isolated individual rejects; their thinking begins to embrace the broader point of view of process control, and rather than rejects, they become interested in uniformity. In short, the cultural opposition to change is weakened, and adaptations of thinking and acting take place.

The engineer begins to see new uniformity; he sees parts made the same within consistent values; he receives more and more and more production requests for re-evaluation of dimensional tolerance. He is brought more and more into the production picture; he begins to see that because he puts a tolerance on a blueprint, there is a possibility it cannot be economically met; he begins to learn more and more that if he consults QC, they tell him what tolerances it is possible to hold economically; and as freedom of conversation occurs, more and more mysterious secrets of tests for significance, tests for design evaluation, and so forth, begin to lose their mystery and the resistance to the "this tolerance cannot be held" and so forth begins to take a new meaning. By close contact with QC and through them, with production, he finds that QC instead of usurping his role as lawmaker strengthens acceptance of his laws as possible and practical. He begins to take into consideration costs to manufacture rather than standard practices for good engineers.

He finds his designs being influenced by customer likes and production acceptance. He is adapting his thinking and action to the new change.

Conclusion

In conclusion, refer back to the social impact of television on the American way of thinking and acting, of the way the American public is being conditioned to acceptance by sales appeal, by functional ability, by increased employment, greater home comforts, by new educational trends, entertainment, and the broader concept of world affairs, of *seeing* incidents, places and people only previously heard or read about, by on-the-spot coverages, new interests in sports, of a greater familiarity toward actors and actresses met on the street, of an unheard-of product having instant acceptance and remarkable sales because of conditioning the public to its advantages by TV before it hits the market — all these and many more.

If we could possibly utilize this example and its effect on people as a technological change to a culture, we could then consider (or compare) the effect of the technological change imposed on a factory culture by the introduction of a quality control program where the inspectors are technicians and actors or actresses, where the production people are the viewers or American public, and the engineers are the script writers.

Don't you believe there would be less opposition to a quality control program if this were considered and if, above all, we remember the Golden Rule?

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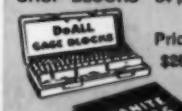

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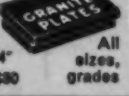

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From the Scrap Box

IRVING W. BURR, *Editor*
Purdue University, Lafayette, Indiana

The Procurement Specification as a Tool for Supplier Evaluation

BARRY A. PALMER

Rocketdyne, Div. of North American Aviation, Canoga Park, Calif.

Sam Jones, purchasing agent for Whiz-Bang Electronics, knew that this morning would be a particularly exhausting one. Promptly at eight o'clock would begin an all-too-common conference concerning rejected parts produced by one of Whiz-Bang's many subcontractors. The script was always the same. Whiz-Bang's manager of quality control would start off by telling the subcontractor's chief inspector that one of the electrical parameters in the subcontractor's parts was out of tolerance. The chief inspector would then retort that this parameter was well within tolerance limits when the parts left the subcontractor's plant. The subcontractor's sales manager would then observe that his plant was the best supplier in his category; and, therefore, they had the best possible test equipment. Whiz-Bang's manager of quality control would then flatly state that all Whiz-Bang test equipment would meet the accuracy requirements of their cognizant government inspector, and that calibration was conducted on a daily basis. The subcontractor's sales manager would note that his plant had reworked doubtfully rejected parts from Whiz-Bang on four occasions in as many months at the subcontractor's expense. Therefore, if the subcontractor must rework these parts; it should be at Whiz-Bang's expense—the parts in question are really all right, anyway. Yet another factor that Sam Jones had to consider was the fact that Whiz-Bang was behind schedule already because this part was not available on the assembly line.

ASQC LCS Code 351:40;70:400

Sounds familiar, doesn't it? Conferences of this sort occur hundreds of times every day in the electronics industry. This is one indication that companies in this industry are in need of a technically valid and rapid means of evaluating the capabilities of present and potential subcontractors, before discrepant parts are in the "house."

The generally accepted method of evaluating a subcontractor is for the customer's Quality Control activity to conduct a survey of the subcontractor's facilities.

If the results of the survey are satisfactory and purchase orders are placed with the subcontractor, the customer's Quality Control activity maintains a continuous audit of subcontractor quality by means of a subcontractor rating plan. These plans take various forms, but they are all based upon a count of rejected parts furnished by the subcontractor.

The most obvious weak point in this system is that subcontractor ratings are made on an "after-the-fact" basis. The damage to the customer has already been done. Other weak points are that very often the subcontractor is unaware of the Quality Control and Inspection procedures at his customer's plant which resulted in his parts being rejected. Not infrequently, there is disagreement between the subcontractor and his customer as to the suitability of a given test procedure or piece of test equipment.

The Quality Control activity has another tool for subcontractor evaluation in the Procurement Specification. A well-written Procurement Specification accurately describes the test and inspection procedures and equipment used by the customer. The customer's Quality Control activity can then evaluate an actual or potential subcontractor by measuring his willingness to accept the results of the customer's procedures, and his technical competence in evaluating them.

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The customer isn't always right —and the subcontractor who can present a technically valid reason why the customer isn't right is probably better than a subcontractor who passively accepts such a procedure.

It is far easier, though, to make an evaluation of technical ability on the part of the subcontractor *before* rejected parts are sitting in receiving-inspection with no place to go.

It is obvious, then, that a well-written Procurement Specification can greatly reduce the probability of misunderstandings between the customer and his subcontractor.

The Procurement Specification

The well-written Procurement Specification should include the following items:

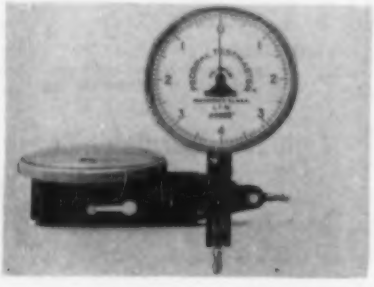
1. A clear statement of the inspection plan to be used by the customer. If a sampling plan is to be used, this plan should be described, especially if rejection of the lot by the sample means the return of the entire lot to the subcontractor. It is understood that there is some possibility that a subcontractor might take advantage of a customer if he knew the sampling plan. Yet, the proportion of dishonest subcontractors is small. Further, the Procurement Specifications can contain a statement that the customer reserves the right to employ 100 percent inspection at his discretion.
2. A list of test equipment to be used by the customer. This should be accompanied by a statement that, in the event there is disagreement as to the suitability of test equipment or inconsistency between the test results of the subcontractor and those of the customer, the customer's Quality Control activity shall work with the subcontractor to obtain agreement. A statement should be included that the customer reserves the right to reject the subcontractor's product until such an agreement is reached.
3. A description of the customer's method for handling discrepant material. For example, does the customer have a Material Review Board? What is the makeup of this Material Review Board? What authority does it have? When and where does it meet? What provisions are made for consultation of subcontractor personnel?
4. A requirement that the subcontractor furnish specified test data. The ability of a subcontractor to furnish test data as required by customer and military specifications should be a prime factor in the customer's rating of this subcontractor.

In conclusion, the Quality Control activity can accomplish three objectives in the preparation of Procurement Specifications. First, a more accurate evaluation of a particular subcontractor. Second, the reduction of misunderstandings between the customer and his subcontractor. Third, by playing a more tangible role in the purchasing operation, the Quality Control activity can augment the professional status of Quality Control.

What's New?

ROY A. WYLIE, *Editor*

1201—A new series of *Test Indicators (T Series)*, with 40 percent less gaging tension and 25 percent less friction than previous models, is announced by Federal Products Corporation. These new supersensitive Testmasters include both large (1½ inch diameter) and regular 1 inch dial models. Inherent accuracy and sensitivity of this series permits the inclusion of a model graduated in fifty millionths of an inch. This greatly improved accuracy and sensitivity is achieved primarily by a more responsive internal mechanism, plus the introduction of a new counter-balanced indicating hand and full-jeweled bearings throughout. Mounting dovetails of the new super-sensitive series are cast integrally with the case to prevent any chance of their becoming loose while the indicator is in use.



This new series is stocked in addition to Federal's standard M series, which is now offered in a greater choice of magnifications, minimum graduations, and dial sizes than in the past.

* * *

1202—National Spectrographic Laboratories, Inc., announces the development of a new, highly sensitive, electronic MICROPHOTOMETER. Known as the *"MSL SPEC READER"*, this new aid to spectrographers, measures the density of the spectrum lines on a film or plate, in order to determine the chemical elements and their quantity in the sample being tested. This unit features the exclusive NSL DIGITAL READOUT AND LOCK. The operating time to read the spectrum lines is reduced more than 50 percent by eliminating the duplication of check readings. Accurate photometrey is assured with sensitivity of less than 100 square microns. Extra large screen, with bright line-of-light permits the operator to clearly see the line he is reading, and all other lines.

* * *

1203 — Thwing-Albert Instrument Company offers a new *Wet-Rub Tester* which provides a reliable method for the quantitative evaluations of coated papers. The test method involves wrapping the test specimen around a stainless steel drum and rotating it against an idler roll covered with smooth-surfaced gum rubber. This provides a slip-free operation. The effective weight of the idler against the sample may be varied by means of auxiliary weights supplied with the instrument. The weight of solids removed from the sample during a predetermined number of revolutions is readily obtained by evaporation of the reagent grade water through which the sample rotates during test. The instrument and the associated test procedure exhibit exceptional repeatability.

* * *

1204—Introduction of a compact, automatic *Under Weight Rejector* for detection of missing components within package units is announced by Illumitronic Systems Corp. The new unit, identified as *Model UWR-1*, handles closed packages in a weight range up to seven pounds. The equipment accomplishes 100 percent rejection of all units under a predetermined weight, within an accuracy tolerance established by line speeds and product characteristics. As the package flow moves across the machine, a flipper reject mechanism discharges underweight units off the Mylar carrier belt. Speeds up to 300 packages per minute are achieved. Model UWR-1 measures 24 × 24 inches. Height is adjustable. All electronics are solid

state, plug-in units, located in the weigh cell. This model is suited to detection of missing components within packaged units, as well as rejection of underfills.

* * *

1205 — The *Brookfield Rheolog* for continuous laboratory indicating and recording of viscosity can give continuous, automatic and direct determination and a permanent record of viscosity. With direct reading in centipoises, the Rheolog will determine such non-Newtonian properties as pseudo-plasticity, plasticity and dilatancy. It may be used to obtain flow curves of thixotropic, rheopectic, time depedent and temperature dependent materials. The Rheolog is portable, explosion-safe and offers the optimum in flexibility. Depending upon model (1, 4 or 8 speed), readings are obtainable from 0 to 64,000,000 cps, and the ratio of maximum to minimum range can be as high as 80,000:1. The Brookfield Rheolog is compatible with standard indicating or recording equipment from a simple pressure gauge to a strip chart recorder and is available with pneumatic or electric signal transmission. Remote transmission is possible at distances up to 100 feet.

* * *

1206—*New Flowtronic 55 Series Air Velocity Meter* provides direct readings of air velocities from 0-4000 fpm and air and surface temperatures from 20°F to 220°F. An eight transistor circuit provides rapid and damped meter response and an electrical output whose response is d.c. to 1 kc. The instrument is powered by 115 v.a.c. or by rechargeable nickle cadmium batteries. High sensitivity at low air velocities is featured.

* * *

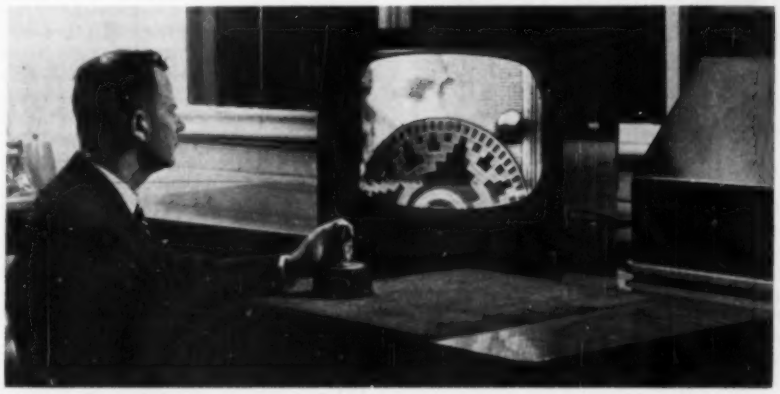
1207—A new quality control computer continuously computes and indicates mean value and standard deviation. With this computer the mean value and standard deviation is known at every instant while a process is in operation. The computer will accept an input from any continuous measuring device—either a voltage of at least 50 millivolts full scale or a transmitting slidewire. In addition to the direct reading meters, outputs are provided for recording. The output signals can also be used for control purposes such as resetting controllers in the process for developing trends. Various configurations of the *On-Line Statistical Computer* are available.

* * *

1208—*A new television comparator* that permits examination and precise measurement of miniature solid objects, with magnification up to 300 times, is available from General Precision, Inc. The closed-circuit television system enables an operator to inspect and examine, in minute detail, components such as transistors, resistors, diodes, microminiature wafers, instrument and watch parts, and subassemblies. The unit can also be used to examine and study live biological specimens and standard laboratory slides. Using a single aircraft-type control stick, an operator can position the image on the screen, and change its magnification through the entire range without loss of focus. A simple accessory to the television comparator permits precise measurement of an object or any portion of it at three times the magnification of conventional comparators.

* * *

1209—The new *super precision dial indicators* introduced by the L. S. Starrett Co. have an A.G.D. accuracy of plus or minus 0.00005 inch for the 0.015 inch total range (2½ turns). Starrett No. 25-109 is a bal-



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anced dial indicator with a range of 0-3-0, one revolution 0.006 inch, total range 0.015 inch. Starrett No. 25-209 is a continuous dial model, reading 0-6, one revolution 0.006 inch, total range 0.015 inch. Both indicators are furnished with jeweled bearings.

* * *

1210—A *new precision measuring instrument*, developed by Boice Gages, Inc., provides a simple, economical solution to gaging problems in applications where large amounts of stock must be removed; yet dimensions must be periodically checked with a degree of accuracy usually associated with final finish. The device is a combination of a mechanical dial indicating gage, which provides ample range for deep cuts, and an electronic indicator which automatically becomes activated, to check with extreme accuracy, as finish size is approached. Applications in which the new combination gage has been found useful include turning of forgings, and boring mill, lapping, honing and jig boring operations where the hole must be constantly maintained within narrow limits. The electronic indicator is battery operated and the gage is completely portable. Model illustrated will gage bores from ¼ inch I.D. up. The principle can also be adapted to gages other than bore gages.

* * *

1211—An *electronic micrometer* precision measuring system displays exact measurements to 10 millionths of an inch on a 5-digit counter and automatically plots the values on a chart recorder. Readings are taken on any pre-selected time cycle. The micrometer head is temperature compensated. Head, control unit and recorder may be remotely located from each other. The system is well suited for automatic recording of small displacements over a long period of time. Typical use: Dilatometer measurements of material expansions at elevated temperatures.

* * *

1212—Aircraft maintenance inspection for cracks, and demagnetization of critical airframe or engine steel components can now be performed quickly between flights with a *mobile magnetic particle test unit*, just announced by Magnaflux Corp. This new ground support equipment, designated *Type KRQS-6*, provides 6,000 amperes direct current for testing landing gear, supports, engine mounts, attachment fittings, and other hardware subject to fatigue cracks from vibration, rough flights, or hard landings. To eliminate any disruption of magnetic compasses from magnetized steel parts, complete, automatic demagnetization is accomplished by means of a built-in motorized 30-point switch and circuits. The power pack is mounted on an 8 feet, 4 inches long, 57½ inches wide trailer frame. Spring suspension and 16 inch tires permit the unit to be towed safely to and from the aircraft at a speed of 20 mph by means of a 34 inch A-frame tow bar. A 34 inch × 15 inch × 33 inch weatherproof storage cabinet attached to the power pack provides ample space for magnetizing cables, prods, spray guns, magnetic particle materials, and a flame-resistant, vinyl-coated canopy that covers the unit when not in use. The KRQS-6 unit is built to operate from either 220 or 440 volt, 50/60 cycle, 3 phase current. Magnetizing cables can be equipped with coils for longitudinal magnetization. An isolation transformer furnishes 110 volts for the control circuits and a convenience receptacle for operation of a powder blower, lights, or other auxiliary equipment.

* * *

1213—A *new transistor test set* has been developed by Fairchild Semiconductor to test very low leakage such as encountered in silicon Planar and Planar Epitaxial transistors. The new *Type 1193* I_{CBO}/I_{EBO} low current tester is essentially a go/no

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1961 Edwards Medal Nominations

Nominations are now being received by the Edwards Medal Committee for consideration with respect to the Edwards Medal for 1961.

The purpose of the award, as established by the Board of Directors in 1960, is to honor individuals who have demonstrated outstanding leadership in the American Society for Quality Control and in the practical use of modern methods of quality control, especially by application or organization and administration of quality control work. It is intended to supplement the Shewhart Medal which recognizes theoretical and technical development rather than application and administration accomplishments.

The Medal was struck in honor of Mr. George D. Edwards, the first president of our Society, and the first Medal was awarded to him at San Francisco. The recipients of the Medal have been:

1959—Simon Collier 1960—Wade Richard Weaver

Any member of our Society may submit nominations for candidates for the Edwards Medal Award. However, it is important that complete biographical information be submitted, supporting the nomination. Only then can the Edwards Medal Committee give adequate consideration to the qualifications of your nominee.

Please see that the name of your nominee is forwarded with six (6) copies of the supporting information to the Edwards Medal Committee through your section chairman, or send them direct to the chairman of the Edwards Medal Committee, A. P. Deacon, 36 Bridge Street, Brantford, Ontario, Canada.

To receive consideration the complete information must reach the committee by December 31, 1961.

go tester. The 1193 will test leakage currents from 1 picoamp (1 micro-microamp) to 1 microamp for both NPN and PNP transistors, at an accuracy better than plus or minus 1 percent above 10 picoamps and plus or minus 5 percent below 10 picoamps. The unit can be programmed for collector-to-base and emitter-to-base voltages from 0-100 volts in 1 volt steps. Transistor or circuit noise does not affect the accuracy of the test. Also, the unit has a built-in current limiting device to protect both the test equipment and the device under test. In addition to testing low leakage current, the Type 1193 can measure resistance as high as 100 kilo-megohms to an accuracy of plus or minus 1 percent; resistance to 1000 kilomegohms to an accuracy of plus or minus 5 percent. The tester can also perform diode I_R tests. The low current I_{CBO}/I_{EBO} tester is priced at $1995.

New Literature Available

1230—A *complete catalog* published by Techni-Rite Electronics features an entirely new line of transistorized, precision, low-cost gaging instruments. Included are the Minicom Amplifiers, Minicom Height Gage, Bench Comparator, Dice Thickness Gage and Minigage Head.

* * *

1231 — *Bulletin X60-B* describes a new optical polygon for use in checking alignment and angular spacing in any multiple of full degrees. Model MOX-3600 Milichex Optical Polygon consists of an optical mirror on a high precision rotating base that can be indexed 360° in single degree increments. Accuracy is within ¼ second of arc (equivalent to 12-millionths of an inch at a 20 inch diameter.)

* * *

1232 — General Electric *Bulletin GEA-6817A* describes G-E's Type H line of portable, halogen sensitive, electronic leak detectors for industry, research and defense applications. All leak detectors discussed are sensitive enough to precisely locate pressure and vacuum leaks as small as 1/1000 cu. in./day. They include: Gun Detector, Type H-2, and PencilProbe Detector, Type H-5. for inspection of welds, seams, joints, and other suspected areas of leakage in pressure systems; Stationary Detector, Type H-3, for completely automatic production line leakage testing; Vacuum Detector, Type H-4, for vacuum system leakage checks.

* * *

1233—A new illustrated *booklet* entitled *Strain Recording with Brush Direct Writing Recorders* is now available from Brush Instruments. This booklet describes the application of strain gages and strain gage based transducers for accurately recording strain, tension, thrust, load, torque, etc. Basic strain recording circuits are shown for recording from one, two, or four-active gages, and techniques used to obtain precise recording of both static and dynamic strain phenomena are explained. Also describes circuits for temperature compensation and for elimination of errors in Wheatstone bridge circuits.

* * *

1234—Central Scientific Co. has published the *J-300 General Catalog*. It contains 1008 illustrated pages showing the complete line of over 18,000 Cenco instruments and equipment for research, educational and industrial laboratories. For convenience of users, a special listing has been included of Cenco equipment required for many of the tests of the American Society for Testing Materials, American Petroleum Institute and the American Association of State Highway Officials.

Inquiries for the following new literature may not be addressed to Product Education Service. Requests for literature, any payments when required, should be sent to the companies listed below.

Three new Supplements on Instruments and Apparatus to the Power Test Code, published by the American Society of Mechanical Engineers, are now available for purchase, according to an announcement by the Society. They are titled "Temperature Measurement;" Measurement of Shaft Horsepower;" and "Measurement of Rotary Speed." Copies, at $2.00 each, are available from the ASME Order Dept., 29 West 39th St., New York 18, N.Y.

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Eliminate "backward" interpolation, for years a problem associated with conventional depth micrometers! Be sure of your measurements . . . always . . . with Speedmike Direct Reading
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section briefs

AKRON-CANTON . . . Pre-meeting seminars for the Dec. 14 meeting are entitled "Professional Developments" and "Reliability" with the latter being moderated by L. W. Miller.

D. E. Gorsline

ALBUQUERQUE . . . The Sept. 13 meeting was a buffet dinner meeting. Our guest speaker was E. J. Lancaster. Topics presented were "Plans and Goals at the National Level" and "The Need for Improved Information Systems for Quality Decisions."

J. A. Woodley

ALLENTOWN-BETHLEHEM . . . Two separate courses in "Design of Experiments" are being offered. Richard Zwickl of Western Electric is teaching one at Muhlenberg College, and one is offered at Tamaqua High School in lieu of an "in plant" course for QC people at Atlas Chemical. Irv Yeager, also of Western Electric, is instructor.

At our last meeting Wm. J. Masser, manager of QC engineering service at General Electric, presented an interesting paper entitled "Management Aspects of QC."

The Western Electric panel of experts headed by Fred Stonehill and consisting of Ken Stephens, Irv Yeager, Bob Mantz, Bob Tust and Dick Zwickl journeyed to Reading's first meeting and discussed the entire QC program at Western Electric.

Robert L. Horstman

BATTLE CREEK-KALAMAZOO . . . Our first meeting of the year was held at the Sutherland Div., KVP Sutherland Paper Co., Kalamazoo on Sept. 21. John H. Baker, vice-chairman of the Rochester section, presented "How an ASQC Section Can Benefit Its Members and Industry." Mr. Baker is with the Eastman Kodak Co., Rochester, N.Y.

Dr. Robert M. Thrall of the University of Michigan will speak on the subject "An Introduction to Operations Research" at the Dec. 21 meeting.

Peter F. Koets

BUFFALO . . . The Sept. 25 meeting was held at the Executive Hotel, Buffalo at 8:30 after a 6:30 dinner. Richard A. Freund, who is in the Applied Mathematic Section, Management Systems Development Div., Eastman Kodak, spoke on some recent developments in control charts. He compared the sensitivity of the Shewhart Chart as compared to the cumulative sum charts or the geometric moving-average chart.

Irving Gordon

CHATTANOOGA . . . On Sept. 12 a group of 25 members and guests attended a dinner and technical session at the Town and Country Restaurant. Prof. T. E. Geraghty of the University of Chattanooga presented "Statistical Techniques in Industrial Engineering."

Glen Franklin

CHICAGO . . . A total of 135 members and guests attended the plant tour of the Teletype Corp. on Sept. 13. An analysis of the shop tour was given by Pat Gerard, followed by an address by Warren Jones.

C. B. Herschberger

CINCINNATI . . . At the Sept. 20 meeting A. M. Dexter, director of metrology, Pratt & Whitney, discussed the manufacture of gage blocks and the various problems involved with measuring them accurately.

The technical meeting was preceded by a coffee talk by Sam Bryant, service representative, Texas Instruments, Inc., on "The Trials and Tribulations of a Manufacturer's Representative."

B. E. Charles

CLEVELAND . . . The Dec. 1 meeting will be "Ladies Night," which has always been one of the most popular events on the calendar.

N. A. Burkhardt

COLUMBUS . . . On Sept. 20, a plant tour was made at Continental Can, manufacturers of flexible packaging materials. The processes observed included gravure printing, laminating, extruding, coating, slitting and fabricating of bag and pouch containers.

On Dec. 5, Dorian Shainin, Rath and Strong, Industrial Consultants, Boston, will speak on "Engineering Product Reliability." This will be a joint meeting with the American Institute of Industrial Engineers at the Battelle Memorial Institute.

M. L. Goeglein

CORNING-ELMIRA . . .This month's meeting will include a tour of the Corning Glass Works, Pressware Plant, manufacturers of television tubes.

Robert H. Rahiser, senior QC engineer, Westinghouse Atomic Fuel, Commercial Manufacturing, substituted for Frank Caplan at the last meeting. Mr. Rahiser presented "QC in the Job Shop."

Allan Erny

CUMBERLAND . . . A talk on "EVOP in Operation" by O. R. Weaver, director of QC at Phillips Chemical Co., will highlight the Dec. 5 meeting. The discussion of evolutionary operation techniques used to optimize a process through plant experimentation made without upsetting production or qaulity should offer a very interesting evening.

A. H. Jaehn

DALLAS-FORT WORTH . . . The newly organized foods division of the section held their first meeting on Sept. 12. Sam Fine, Director of the Food and Drug Administration, spoke on "The Regulatory Power of the Food and Drug Administration as It Concerns Adulterated Foods." The group of 22 met at the Hi-Ho Restaurant in Grand Prairie. Bob Crow of Armour and Co. is acting chairman.

A panel will discuss "QC Responsibilities, Rights, Authority" at the Dec. 17 meeting.

R. R. Massagee

DAYTON . . . Thirty members and guests attended an informal social held at the Delco Products Lodge. Hats off to Walt House, arrangements chairman, on his first effort in that capacity.

At the management night dinner meeting to be held Dec. 14 at the Brown Derby Restaurant, Aaron Sivitz, vice-president and chief engineer of Globe Industries, will speak on "Management Looks at QC."

Bill Smith, a past chairman, spoke before the Greater Muskegon section on Sept. 14 on the topic "Practical Quality Control at the National Cash Register Co."

Ken Holliday

DELAWARE . . . The first meeting of the season, consisting of the members and their wives, was held at the Lord De La Warre Hotel. The guest speaker was Dr. Charles Wood of the FDA Office, Philadelphia, whose talk centered around the work of the FDA in assuring quality in what we eat and drink.

J. Rigney

EVANSVILLE-OWENSBORO . . . The first section meeting was held at Central Turners in Evansville. Walter Richert, chief engineer of Potter & Brumfield, Div. of American Machine & Foundry, spoke on "The Difference in Manufacturing, America vs Europe." Mr. Richert is a graduate of Gauss Engineering School in Berlin and was employed as development engineer by the Deutsche Telephone Werke in Berlin. In 1952 he came to the U.S. and since then has been awarded the "Key Man of the Year Award" for his outstanding work in development of the micro miniature electronic relays now being used in the U.S. missile programs. In 1959 Mr. Richert returned to Germany to visit several relay manufacturing companies in the western zone. Color slide pictures he took on this tour were used to illustrate his talk.

In December the executive committee will meet to plan the annual ladies night program for May, which will require an all out effort in order to match the program presented last year.

W. E. VerWayne

GEORGIA . . . On Sept. 28 at the IE Bldg., Georgia Tech, C. E. Molzahn, manager of quality engineering, Lockheed—Georgia Co., Marietta, will present "Manufacturing Reliability and Process Capabilities."

E. G. Field

GREATER DETROIT . . . On Sept. 16, the 16th Annual QC Forum was held at the University of Michigan at which a wide variation of topics ranging from the relationship between "Quality and the Labor Agreement" to "Automated QC" were presented. The luncheon speaker, Edward McFaul, a consultant in human relations, was most effective in illustrating "How to Keep Your Foot Out of Your Mouth" by showing the need for good communication by use of total and complete instructions to obtain the desired result in any field as well as QC. He told a little story about a construction worker breaking-in a new man. After handing a sledge hammer to the new man, the worker picked up a chisle and holding the chisle on a concrete curb said, "When I nod my head you hit it." This illustration was thoroughly enjoyed by the 289 in attendance.

M. E. Helmke

GREATER MUSKEGON . . . On Dec. 14 this section will hold its fourth meeting of the year at the Red Vest Restaurant at 6:30 pm. The noted Joseph H. Molnar, manager of QC, Houdaille Industries, Inc. will speak on "QC—Management's Tool."

On Sept. 30 the section in cooperation with the Muskegon Manufacturer's Association sponsored the "Western Michigan QC Clinic," which took place at the Occidental Hotel. Top notch speakers and the hard working committees helped to make this event a great success with approximately 300 registrations.

Al Baker

HARRISBURG . . . Elmer Kern, educational chairman, has been busy organizing courses in basic, intermediate and advanced SQC techniques. He secured the services of both J. T. Skelton, Caterpillar Tractor Co., York, to teach the basic and intermediate courses while Ervin F. Taylor, Martin Co., Baltimore, will conduct the advanced course. Forty applications for these sessions have been made to date. The publicity was excellent on this project and the local radio, television and newspapers plus ads helped reach those outside our membership. Juergen Walbrecht is the new publicity chairman.

The Dec. 13 meeting will be held at the Conestoga Country Club, Lancaster. Dinner will be served at 6:45 pm followed by the meeting at 7:45 pm. Harmon S. Bayer, QC Consultant, Detroit, will be the guest speaker and has chosen to present "Machine Capabilities."

Ann Englehart

HARTFORD . . . The executive committee held their September meeting at the home of chairman Gene Ellis.

The Dec. 12 meeting will be held at the Connecticut General Data Processing Center at 7:30 pm. Albert D. Bossom, will speak on "Mechanics and Maintenance of Data Processing." A plant tour will follow.

E. May

HUNTSVILLE . . . The Sept. 28 meeting was held at the Russell Erskine Hotel. William W. Mills, Jr., chief,

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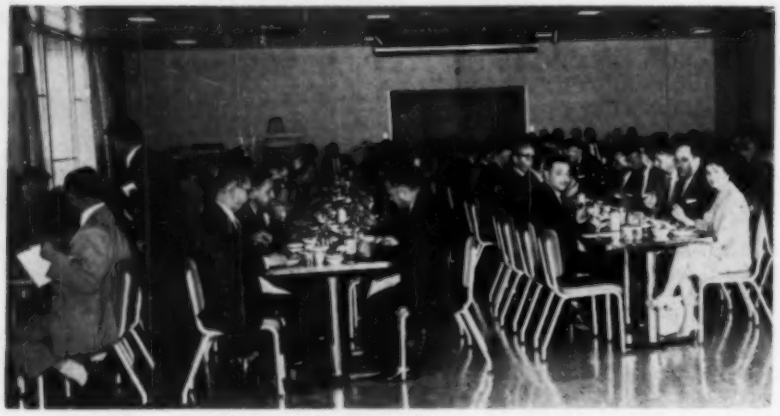
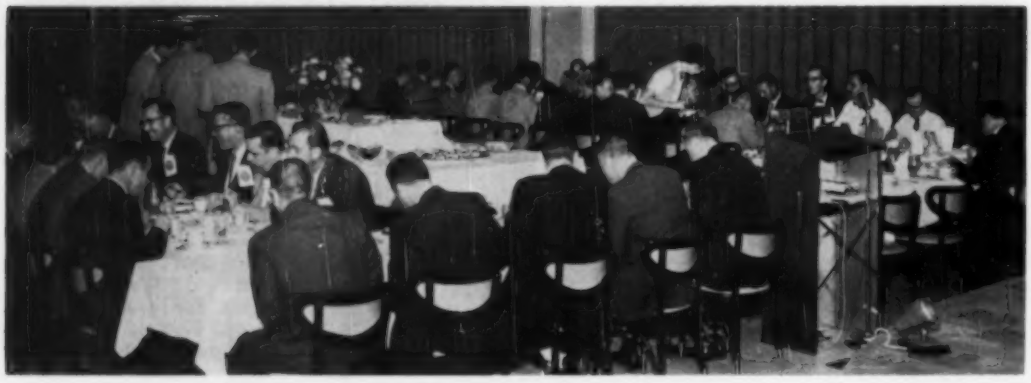
PENSACOLA-MOBILE—Dr. Harlow Aydes, head of the Department of Neurophysiology and Acoustics, U. S. Naval School of Aviation Medicine, spoke at the Sept. 21 meeting.

CHICAGO—A total of 135 members and guests attended the Sept. 13 plant tour and luncheon at the Teletype Corp.



CAPE CANAVERAL SUBSECTION—The newly formed Cape Canaveral Subsection of the Orlando-Cape Canaveral section held a dinner meeting on Sept. 27



METROPOLITAN—Dr. L. Grant Hector, vice president in charge of technical operations for the Sonotone Corp., spoke on Sept. 9 at the 13th Annual Rutger's Conference on Quality Control.

JOPLIN-SPRINGFIELD—Wilder's Restaurant in Joplin was the scene of the Sept. 21st panel discussion meeting.

inspection section, Thiokol, Redstone Div., spoke on "Non-Destructive Testing in the Solid Propellant Rocket Motor Industry" before 26 members and guests. He illustrated his talk with a series of slides to show how thorough a test program on rocket motors must be, including checks on both the multi-component assemblies and composite motor. Things to look for in the near future include usage of plastics and modified metals with the emphasis on strength and low weight. After the meeting, a general interest film was shown on "Washington at Work," a Kiplinger production on behind the scenes activities in many unfamiliar phases of government work.

William Spink

INDIANAPOLIS . . . On Sept. 12 at our kick-off meeting at Butler University, Prof. Gayle W. McElrath, University of Minnesota, presented "The Big Picture."

H. M. Handerson

IOWA, STATE UNIVERSITY OF . . . Simon D. Krasner, Universal Match Co., addressed 25 section members on the subject of "Multiple Correlation in Process Control." Of great interest was a three-dimensional plexiglass control chart. Host for the evening refreshments was the International Harvester Co. with Messrs. Meyers and Hardesty serving.

John Miller

JOPLIN-SPRINGFIELD . . . Our first meeting was held on Sept. 21 at Wilder's Restaurant in Joplin and a nice turnout was on hand. The program for the evening was a panel discussion on "How Quality Control Will Aid in Financial Return." Moderator was vice-chairman Tom Bair. Members of the panel were Floyd Thomas and Byron Anderson, U.S. Army Signal Corps Supply Agency, Jim Ferguson, Lockheed Missiles, and Bill Phillips, Sandia Corp.

When our section announced a course in QC, the response was so heavy that we decided to offer two courses. "Statistical Quality Control" is being taught by Dr. A. J. Miles, Missouri School of Mines and Metallurgy, Rolla, and has an enrollment of 14. "Practical Applications of QC Techniques on the Production Floor" is being taught by Jan DeGraad, engineer, Royal McBee Corp., Springfield, with an enrollment of 22. These courses are being offered in Springfield now but we hope to include Joplin and other towns at a later date.

R. C. Bogart

KANSAS CITY . . . The September meeting was held at the "Brown Bottle" of the Schlitz Brewery. A very fine buffet dinner was served in addition to free samples of the company's product. Some equipment used in QC at the brewery was on display and Don Waldman, Schlitz QC manager, gave a presentation about the history and evolution of the high quality of the company's product. Many members, prospective members, wives and guests were in attendance. Introduction was made of all the new officers and committeemen, and the plans for the coming year were reviewed by chairman Clifford P. Cutler, who also enumerated the many advantages of belonging to the Society for the benefit of the prospective members, wives and guests. Through the years, the kick-off meeting at the Brewery has developed into a membership promotional affair.

V. J. Smeltzer

LANSDALE . . . On Sept. 28 the season was kicked off on an informal note by holding a members and wives "Doggie Roast" at Oak Grove Park, Hatfield. New section officers are chairman Glen Casey, R. T. French; vice-chairman Richard Scholl, U. S. Gauge; secretary Kay Dwyer, U. S. Gauge; and treasurer Carl Garrett, Dana Corp.

The program for the season promises to be a well diversified and interesting one with the format as in the past; guest speakers, attractive events and plant tours.

James R. Borgman

LEXINGTON . . . At the September meeting the year's program was presented under the theme of "QC in the Space Age." Joseph Bernick, The Martin Co., Baltimore, presented "Atomic Energy Goes to Work" using slides of manufacturing, QC and operation as well as the de-

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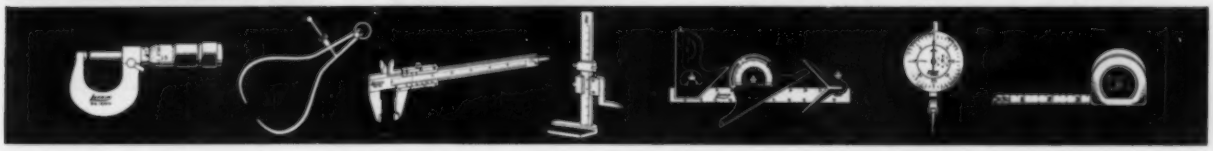

sign features of portable reactors. He also gave a brief explanation of the health physics problems and an introduction to a miniature atomic power supply system being developed for use in satellites and remote weather monitors.

Wives are invited for the December "Ladies Night." An interesting film on "at home" effects of QC will headline the program.

James C. Graff

LIMA . . . The fall quarter educational program conducted by chairman Earl Schmeiding, Westinghouse Electric Corp., will wind up the first step in the new long range educational program being established by the section. The courses being completed are "Control Chart Variations" and "Sequential Sampling Analysis."

Darrell C. Fultz

LOS ANGELES . . . The Sperry Corp. started this section towards a new Saddoris Award season with the mobility of a Sargeant Missile and a strong concept of Sperry's aim in bringing quality and reliability under one management head. John Leete expressed managements needs to meet schedules. Frank McGinnis, director, reliability and QC, Sperry Gyroscope Corp., presented a very interesting paper showing Sperry's united approach of quality and reliability under one head starting the necessary control functions with the proposal stage through R & D and into production. Michael Hogarty, quality manager, Sperry Utah Co., presented the Sargeant Missile quality program and testing approach and acted as chairman for the panel.

On Dec. 19, the Rocketdyne Div., North American Aviation, will present a QC Panel headed by C. W. Guy who will speak on "Engine Reliability for Manned Space Flight." Mr. Heath, QC director, will talk on "Management Objectives in the Quality Program." Special program chairman for the panel will be John Young, North American Aviation.

Steve Kozich

LOUISVILLE . . . There was a record attendance for "Opening Night" with 56 members and guests enjoying a fine social hour and steak dinner at Hasenour's Restaurant. All committeemen made reports that showed signs of progress in all phases of our section activities. The percent of membership renewal by Sept. 1 is higher than ever, and it looks like our total membership will reach a new record. The education committee presented one of the best films on QC with respect to customer complaints. Our guest speaker was Richard Smith, Fuller Adhesive, who spoke on the subject of the attitude towards quality in the U.S.A. and that of some foreign countries.

The theme of this year is "Publicity." Every member is urged to place the advantages of ASQC before their industrial friends. Extra copies of the 1962 program and *The Sigma* are available to everyone as an aid in their personal publicity.

Monroe J. Oates

MEMPHIS . . . This section opened its fall season with a view of QC in the breakfast cereal industry. Over 40 members and guests heard and saw how the Kellog Co. applies QC in regulating moisture in the drying process, temperatures in cooking and weights in packaging. William Porter and his staff in the QC operation conducted a lecture tour of the large Memphis Plant that processes breakfast foods from wheat, corn and rice.

On Dec. 12 Ray Morris, International Harvesters' manufacturing research group, will be in Memphis at the Memphis Works, to speak about the use of "Probability Paper in Industrial Operations." A plant tour will follow a period of refreshments and discussions.

Douglas W. Ferris

MERRIMACK VALLEY . . . The second annual fall symposium was held at Lowell Technological Institute on Sept. 15. The subject for the all day session was "Military Packaging Materials" with primary discussion centering on MIL SPECS, MIL-P-116 and MIL-STD-726

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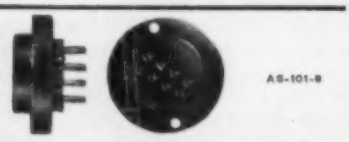

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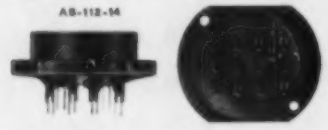

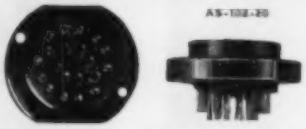

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Fred Ryan

METROPOLITAN . . . The 13th Annual Rutgers Conference on Quality held on Sept. 9 was an unqualified success with a capacity attendance of 625 men and women. Dr. Elmer C. Easton, Dean of the College of Engineering, was again a most interesting and entertaining host. Dr. L. Grant Hector, Sonotone Corp., was a most effective principal speaker. His message was straight from the shoulder with regard to the need for effective application of economically sound QC principles and techniques which will result in a specified quality level, achieved at minimum cost, in order to assure a continuing satisfactory operating profit level. Dr. Hector's serious challenge and his presentation of the vital need for profitable operation merits sober consideration by all persons charged with the responsibility for economical control of quality.

Due to a series of unfortunate events the 1961 Princeton Conference on QC has been cancelled. Dr. Stuart Hunter has tentatively accepted the responsibility for planning of the 1962 conference.

Stephen G. Orban

MILWAUKEE . . . On Sept. 6 this section sponsored a seminar on "Quality Assurance Requirements on Government Contracts." The program, which started at 9:30 am and lasted all day, provided valuable information for all types of suppliers to government agencies. The guest speakers were C. J. Brzezinski, Office of Assistant Secretary of Defense, S. J. Lorber, Army Ordnance, Lt. Col. W. E. Hughes, Department of the Army and Capt. J. A. Barker, Dept. of the Navy. These gentlemen, directly associated with government requirements, presented their interpretations of the contractor's responsibilities in this area. The question and answer period which followed provided additional information regarding specifications, QC manuals, etc. to the more than one hundred contractors representing Milwaukee and surrounding areas.

The regular monthly meeting was held Sept. 18 at the Milwaukee Inn and began with a training session at 4:30 pm, conducted by Tom Owen, Snow Mfg. Co., Bellwood, Ill. His lecture was entitled "Straight Line Concept of Thread Gaging." Roman E. Boruta, QC Manager, Trenton Engine Plant, Chrysler Corp., Trenton, Mich., presented a talk entitled "Inspection—Direct Labor or Overhead?" in which he gave both points of view in the evaluation of inspection costs. This controversial subject resulted in a lively discussion period after his presentation.

Darrell G. Schroeder

MINNESOTA . . . On Dec. 5 a plant tour will be held at Whirlpool Corp., manufacturers of home appliances. Since the turnout should be large, please get your reservations in early.

Grove Ruth, Minnesota Mining & Mfg., was appointed general chairman of the clinic for this year. Ron Arneberg, education chairman, is establishing a new format consisting of a series of short courses, three weeks in duration, one night a week, for a total of six hours. Courses currently planned are "Introduction to SQC," "Acceptance Sampling Theory," "Descriptive Statistics," "Advanced Methods of Sampling" and "Advanced Statistical Techniques."

Corrinne Leko

MONTREAL . . . Our first get-together of the season took place on Sept. 8 in the form of a tour of Labatts' Brewery with F. Loranger, Superintendent of QC, acting as host to 21 members and 36 guests. The group was conducted on a tour of the aging rooms, fermenting rooms, store rooms and the bottling, packaging and brewing areas, after which Mr. Loranger explained the basic processes and described some of the QC techniques used in the brewery. He gave a few examples of some of the things that have to be considered in the brewing business, i.e.; he pointed out that shelf life affects the taste of beer and ale, and that the constituents used in the brewing must be varied relative to the estimate or known shelf life. Mr. Loranger also pointed out that the color of the bottles affects the quality of the beer. After his talk he was called upon to answer a number of questions whose caliber was indicative of the interest shown by the group.

J. J. Fitzsimmons

NEW HAMPSHIRE . . . On Sept. 26 the section held its dinner meeting at Palmer Lodge, Keene. Charles Hudson discussed "Total QC." Prior to the meeting members toured the American Optical Facility in Keene.

J. E. Tarrant

OMAHA-LINCOLN . . . To open the season, a well-attended dinner meeting was held on Sept. 8. Ed Hayes, our section chairman from Omaha Works of Western Electric, and Society Director Sam Grasso, Inland Automatic Co., Omaha, joined forces to present "ASQC For You," which brought the members up to date on both the local and national organization and program of ASQC. This was followed by a question and answer period.

D. L. Van de Water

ORANGE EMPIRE . . . "Production Reliability" was the topic of an address presented by Frank H. Squires, QC Consultant, at the Sept. 5 dinner meeting. Our congratulations to program chairman Chuck Kleppsattel in obtaining Mr. Squires, who substituted for Ben Cogan, manager of quality assurance, Ramo Wooldridge, who was unable to fulfill his speaking engagement at this meeting. Mr. Squires stressed the fact that production personnel must revise their attitude towards meeting the specified tolerances.

Plans for the "Ladies Night" Dec. 5 meeting are currently being formulated. Program Chairman Chuck Kleppsattel announced that a special program of entertainment is planned with the able assistance of Dolly Foster, womens activities committee chairman.

Henry W. McKee

ORLANDO-CAPE CANAVERAL . . . A special meeting was held with representatives of many organizations in the Cape Canaveral area to explore the potential of forming a subsection. The enthusiasm of this meeting

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generated the following committees and officers: program—Warren Welch; membership—Dorsey Dean; publicity—R. H. Nicholson and Robert A. Cooper; chairman—John T. Hagan; vice-chairman—Robert A. Nanz; secretary—John E. Wilburn; treasurer—Murray Hack; directors—Philip B. Crosby, William E. Rooney and Robert A. Messier.

The Cape Canaveral meeting of Sept. 27 featured Dr. James R. Duffet, Space Technology Laboratories, who spoke on the subject "Redundancy—Friend or Foe." The meeting attracted 60 members and guests. Chairman John T. Hagan stressed the theme "Getting to Know You" for future meetings. The Dec. 5 meeting will be a joint effort and we hope to have J. Y. McClure, Junior Past President of ASQC, to speak on the organization and advantages of ASQC.

On Sept. 28 at the Orlando meeting George Henderson of Martin-Orlando spoke on "A Discussion of the Effects of Some Quality Practices on Reliability." General Leslie E. Simon, Retired, winner of the first Shewhart Medal and Consultant to the Carborundum Co., and Len Seder, who is presently on an assignment as a consultant to the Minute Maid Corp., were present. Mr. Seder was the guest of Charles Brohow.

Our meetings have been widely publicized in this area on four radio stations and in five newspapers which has aided immensely in generating enthusiasm to get our organization off to an orbital start.

R. H. Nicholson

PARKERSBURG . . . On Sept. 19 the executive officers assembled at the Wakefield Hotel, Marietta, for dinner followed by the business meeting, which was very fruitful.

The December meeting will be Ladies Night and will be a joint program of AIChE, ACS, ASME and ASQC. Our program chairman reports that a nationally known speaker will be secured.

Robert R. Stewart

PENSACOLA-MOBILE . . . The first program of the 1961-62 season was held at the Town House, Mobile. Dr. Harlow Aydes, U.S. Naval School of Aviation Medicine, presented the group with a most interesting talk on the parallel of experimental phases of neurophysiological research and standard QC procedures.

On Dec. 7 there will be a Ladies Night meeting in Pensacola. The speaker is being kept a mystery but has been promised as being an attention holder.

David A. Haddock

PEORIA . . . On Sept. 25 the first meeting was held at Vonachen's Junction Restaurant. Elmer D. Myers, QC Specialists, U.S. Army Ordnance, was the speaker and led some 60 members and guests surefootedly through the labyrinthine paths of "Government Contracts and Vendor Certifications."

R. H. Greenan

PHILADELPHIA . . . The Sixth Annual Symposium on QC Methods & Management was held at the Ogontz Campus, Pennsylvania State University. The combined monthly meeting and symposium included presentations on QC Management, Applied Statistics and Reliability. The dinner speaker, E. M. Schrock, American-Standard Co., Baltimore, addressed the group on the subject of "Management Bench Marks for QC." Copies of the transactions are available from R. P. Davis.

The Christmas Social Evening will be early this year. Make your reservations now for Dec. 2 at the Germantown Cricket Club.

D. N. Ekvall

PITTSBURGH . . . At the first dinner meeting of the season, Mr. Truax, Manager of QC, Atlas Powder Co., spoke on "Cumulative Sum Charts" as a simple charting technique for use in process control, and pointed out its use in graphical reduction of noises which are observed on regular control charts, thus providing faster detection and correction of real process deviations.

Robert H. Rahiser

RACINE . . . On Sept. 18 the first meeting was held at Krok's. Carl A. Roesch, American Motors, was the guest speaker. He addressed 40 people from Racine and Kenosha. A short film titled "Miracle of Pike Creek," gave the inside story of how American Motors got started and how it has done so well in quality. A question and answer period followed.

Joseph Yahnian

RHODE ISLAND . . . Hurricane Esther washed out the Sept. 21 meeting.

Educational chairman Winston Hamblet, Instrument Development Labs., announced that 36 students enrolled for the first 15 week quality assurance course that is being conducted in conjunction with the Rhode Island Extension School.

Paul K. Moffat

RICHMOND, VA. . . . Our first meeting of the season was held at the Officers' Club, Richmond Quartermaster Corps Depot. Sam Skolnik talked on "High Reliability Sampling Tables and Their Mathematical Derivation." Opening remarks were delivered by Captain William G. Blasdel, USN, Quartermaster Depot.

J. H. Leith

SACRAMENTO . . . Sixty-seven percent of the membership and 160 non-members attended the September meeting at which Mr. Geckler was the guest speaker.

We are looking forward to the annual Ladies Night in December.

M. K. Walker

SALT LAKE CITY . . . On Sept. 26 this section held their opening fall meeting at Ma & Pa's, Roy. Dr. Alex Mood, CEIR, discussed "Optimum Reliability in Defense Weapons Systems." Eighty-five persons were in attendance including several from Burley, Idaho.

David M. Stewart

SAN ANTONIO . . . On Sept. 16 the second successful annual QC symposium was held at the Granada Hotel. The theme, "The Scope of QC," was very well depicted as six nationally known authorities presented a variety of subjects of benefit to this area. Papers on management, reliability, industrial applications, vendor relations, research and non-destructive testing were presented. Speakers were: B. E. Justice, Convair; M. R. Seldon, Vought Astronautics; J. Schneider, IBM; Dr. Burger, Lone Star Brewery; A. M. Dexter, Pratt & Whitney; William Cory, Southwest Research Institute.

The annual Christmas party and dance will be held on Dec. 19.

R. W. Worrick

SAN BERNARDINO . . . The Sept. 21 meeting marked the advent of a new program feature; "Inspectioneering Workshop" headed by J. C. Powlesson, Jr., Aerojet-General Corp. Dr. Max Astrachan, The Rand Corp., discussed the nature of "Operations Research as a Way of Thinking About Management Problems."

The Dec. 13 meeting will be held at 7:00 pm at the Mural House, Ontario. F. A. Peck, QC Manager, Consolidated Electro-Dynamics Corp., Los Angeles, will present "Cost Control."

Gene A. Williams

SAN DIEGO . . . The first meeting on Sept. 11, sponsored by Solar Aircraft Co., featured K. R. Willhite, affiliated with Rocketdyne Div., North American Aviation, who spoke on "Maximizing the QC Effort" and was well received by a capacity audience. This was followed by a question and answer period.

A program of special appeal to those of our members who are involved in the staff and planning functions of QC is planned for the Dec. 11 meeting. D. H. Perry, Western Contract Management Region, will speak on "Air Force Quality Audit."

S. Greenbaum

SAN FRANCISCO . . . The Eighth Annual Bay Area QC Conference held at Stanford University on Sept. 12 was a huge success with attendance exceeding 250.

Our speaker at the Dec. 12 meeting will be Sam Carrol, Texas Instruments, whose subject will be "Management of Quality Assurance." The meeting will be held at Ramor Oaks, Atherton.

Thomas L. Russell

SANTA MARIA-VANDENBERG . . . Our first meeting was held on Sept. 19. R. G. Paul, Douglas Aircraft, presented an informative talk about the Douglas method for "Monitoring Reliability Programs." The dining room of the Las Flores Inn was filled to capacity by attendees representing General Electric, Ferguson-Smith, Lock-

heed, Douglas, Wire Company of America, Convair, Martin, Boeing and the AMC QC Group.

Our Dec. 18 meeting will be a "Bring the Wife Along" affair at Ricks Rancho in Santa Maria.

Victor E. Johnson

SEATTLE . . . The first meeting of the year was held at the new plant of United Control Corp., Bellevue. Charles W. Long, section junior past president, provided a tour of the plant, followed by a film on the development of their products and the part QC plays in their operation. This was followed by a social hour.

James J. Whyte

SOUTH BEND-MISHAWAKA . . . On Sept. 21 this section was the guest of the McGill Mfg. Co., Valparaiso. James Newberry, QC Mgr., discussed "QC in the Bearing Industry." A tour of the plant followed.

F. M. Ahrens

SOUTHERN CONNECTICUT . . . On Sept. 13 a "Joint Engineering Council" was held at Mary Journey's Inn, Bridgeport. After dinner, Ernest Greenwood, Norden Div., United Aircraft Corp., Ralph Lightfoot, Sikorsky Aircraft, and William Vermeulen, General Electric Co., participated in a panel discussion entitled "Engineering-Management Responsibilities in the Utilization and Development of Technical Personnel."

The Jan. 10 meeting will be held at the Bryant Electric Co., Bridgeport. H. Wunsch, Fonda Gage Co., will speak on "Gages—Foundations of Accuracy." There will also be an exhibit by the Standard Gage Co.

William E. Wells

SYRACUSE . . . On Sept. 12 A. L. Davis, Rochester Institute of Technology, spoke on a subject of great interest to all—"The Beginning of the Society." Among the highlights of his talk was a moving tribute to Dr. Martin Brumbaugh and his fine and outstanding contribution to the stature of ASQC.

On Sept. 19 George Endrich, a member of this section and General Electric Heavy Military Electronics Dept., spoke to the Rochester section on the subject of "Professionalism."

F. A. Bullard

TENNESSEE . . . On Sept. 4 section officers met with some members in Nashville. Plans were made for the formation of a subsection in Nashville and its surrounding area. Interest was indicated in the expressed desire of enrolling enough members to become a section in the near future. The first meeting will be held at Nashville.

Members of the Tennessee and Northeast Tennessee sections met recently at Kingsport to organize the program for the QC Clinic which will be held at the University of Tennessee in March.

Eric E. Johnson

TOLEDO . . . An excellent discussion of short cuts in sampling was presented by E. B. Godsey, Collins Radio Co., Cedar Rapids, Iowa, on Sept. 7.

The annual Christmas Party for members, wives and guests will be held at 8:00 pm on Dec. 8 at the N.Y.C. Sportsmen's Club, South Byrne Road near Chicago Pike, Toledo.

James E. Davis, QC Supervisor, Johns-Manville Fiber Glass, Defiance, will moderate the first meeting of the new year on Jan. 4. William A. Shideler, Quality Engineer, Eaton Mfg. Co., Battle Creek, Mich., will present "Effective Techniques in Presentation of Data to Secure Action."

R. E. Rockwell

TORONTO . . . On Sept. 13 this section met at the Canadian General Electric Co. auditorium to hear a talk entitled "Introduction to Reliability" presented by Nicholas P. Demos, Data Systems Engineer, General Electric Co., Schenectady, N.Y.

On Sept. 20 the executives met and the date of Mar. 10 was set for the all-day forum to be held at the King Edward Sheraton Hotel, Toronto.

E. C. Underwood

7th ASQC Workshop-Seminar

MANAGEMENT OF QUALITY CONTROL

January 25 - 26 - 27, 1962

Sheraton-Blackstone Hotel, Chicago, Ill.

What is the purpose of the workshop seminar? To explore in depth, tested methods of increasing the effectiveness of the quality control program in an industrial plant.

For whom is the program planned? For present and prospective Quality Managers. It is expected that the applicant will have reasonable familiarity with such standard texts as Grant, Feigenbaum, and Juran. To benefit properly from the seminar, the applicant should have a minimum of several years experience with major responsibility for quality.

Registrants will be sent study materials and case studies prior to the conference. Registration is limited to 75 persons and is complete only on receipt of the registration fee of $125 for non-members, $100 for members, which includes the cost of three lunches.

Your Registration will be acknowledged. A room reservation card for the Sheraton-Blackstone Hotel will be enclosed with the acknowledgment.

ASQC Institute

Paul C. Clifford, Director

Seventh ASQC Workshop - Seminar
ASQC Institute
161 West Wisconsin Avenue
Milwaukee 3, Wisconsin

Please make reservations for the Seventh ASQC Workshop-Seminar on Management of Quality Control for the following man:

Enclosed is our check for $..... to cover ..... registrants. Fee—$125 for non-members, $100 for members.

Name .....

Title .....

Company .....

Address .....

City..... **Zone No.**..... **State**.....

NOTE: Additional registrations may be made by attaching a list to this coupon. Please include necessary information for each registrant.

SECTION (CALENDAR (DECEMBER 1 TO JANUARY 10)

SECTION	DATE	PLACE	TIME	SUBJECT	SPEAKER
Akron-Canton	Dec. 14	Town and Country Restaurant	8:00 pm	Reliability Analysis	Dr. G. Ronald Hurd
Albany	Dec. 5	Hot Shoppes	5:30	Joint Meeting, ASQC-ASA (ASA—Host)	.....
Allentown-Bethlehem	Dec. 13	Hotel Traylor	8:00	Work Shop	.....
	Jan. 10	Hotel Traylor	8:00	.....	.....
Battle Creek-Kalamazoo	Dec. 21	.....	8:00	Introduction to Operations Research	Dr. Robert M. Thrall, Univ. of Michigan
Chattanooga	Dec. 5	Wimberly Inn	6:30	Ladies Night	.....
	Jan. 9	Elks Club	6:30	Inventory Control	G. G. Parkin
Cincinnati	Dec. 13	Engineering Society Bldg.	6:30	Application of Analytical Techniques & Experimental Designs	R. W. Anderson, Texas Instruments
Cleveland	Dec. 1	Cleveland Engineering Society	7:45	Western Badmen, Quality & Quantity	J. W. "Bill" Waters, General Electric
Columbus	Dec. 5	Battelle Memorial Institute	8:00	Engineering Product Reliability	Dorian Shainin, Rath & Strong
Corning-Elmira	Dec. 12	Corning Glass Works, Pressware Plant	7:30	Plant Tour	A. P. Stergion
Cumberland	Dec. 5	Ali Ghan Shrine Country Club	6:30	EVOP in Operation	O. R. Weaver, Phillips Chemical Co.
Dallas-Fort Worth	Dec. 7	Hi Ho Restaurant, Grand Prairie	6:30	QC Responsibilities, Rights, Authority	Panel Discussion
Dayton	Dec. 14	Brown Derby	6:30	Management Looks at QC	Aaron Sivitz, Globe Industries
Evansville-Owensboro	Dec. 12	Evansville	6:30	Executive Meeting	.....
Greater Detroit	Dec. 14	Chrysler Training Center	8:00	Effective Techniques in Presentation of Data to Secure Action	Wm. H. Shideler, Eaton Mfg. Co.
Greater Muskegon	Dec. 14	"Red Vest" Restaurant	6:30	QC—Management's Tool	Joseph H. Moinar
Harrisburg	Dec. 13	Conestoga Country Club, Lancaster	6:45	Machine Capabilities	Harmon S. Bayer, QC Consultant
Hartford	Dec. 12	Connecticut General	7:30	Mechanics and Maintenance of Data Processing	Albert D. Bosson
Indianapolis	Dec. 12	Butler Univ., Atherton Center	7:30	Members' Night	Panel of Practicioners
Kankakee-Joliet	Jan. 9	Kankakee	6:30	Fundamental QC Ideas	C. D. Larson, General Tire & Rubber Co.
Kansas City	Dec. 14	Elks Club	6:00	QC Programs Should be Cost Reduction Programs	W. D. Gay, Bendix Corp.
			8:00	Summary of Latest Information on Professionalism	J. C. Tepper, Western Electric
Lexington	Dec. 14	Lexington Signal Depot	7:00	Ladies Night	Film Presentation
Lima	Dec. 5	Holiday Inn	6:30	Discovery Sampling	E. F. Taylor, The Martin Co.
Los Angeles	Dec. 19	IAS Building	6:00	Surface Roughness	Gil Austin
			7:00	Rocketdyne Panel Presentation	.....
Louisville	Dec. 11	.....	6:30	Protective Coatings	Dr. James Scott Long
Memphis	Dec. 12	Memphis Works, International Harvester	7:30	Use of Probability Paper in Industrial Operations	Ray Morris, International Harvester
Merrimack Valley	Dec. 7	Lawrence	6:30	Food Processing	.....
Metropolitan	Dec. 6	.....	7:45	Professionalism	Dr. A. V. Feigenbaum, General Electric Co.
Milwaukee	Dec. 8	Milwaukee Inn	7:30	Management Night	Warren R. Purcell
Minnesota	Dec. 5	Whirlpool Corp.	1:00	Plant tour	.....
	Jan. 9	American Legion Post	6:30	What Statistics Does a QC Engineer Use	Harold Guide, Minneapolis-Honeywell
Montreal	Dec. 13	Imperial Tobacco Co.	10:30 am	QC in a Cigarette Factory	Panel Discussion
	Jan. 10	Ecole Polytechnique	8:15 pm	The Matrix Algebra of Experimental Design	G. L. Cockhill, Shawinigan Chemicals
Omaha-Lincoln	Dec. 8	Omaha	6:30	Plant Tour (Tidy House Products)	Wayne M. Boand
Orange Empire	Dec. 5	Waterwheel Restaurant, Anaheim	7:15	Ladies Night	.....
Orlando-Cape Canaveral	Dec. 5	Cocoa Beach	6:30	ASQC—The Organization and the Advantages	J. Y. McClure, General Dynamics Corp.
Pensacola-Mobile	Dec. 7	Holiday Inn, Pensacola	6:30	.....	.....
Pittsburgh	Dec. 12	Skibo, Carnegie Inst. of Tech.	6:30	Non-Parametric Test	E. C. Harrington, Jr., Monsanto Chemical
Sacramento	Dec. 5	.....	6:00	Economic Trends vs. The Stock Market	Ludy Langer
San Antonio	Dec. 19	Kit-Kat Club	7:30	Christmas Party & Dance	.....
San Bernardino	Dec. 13	Mural House, Ontario	7:00	Cost Control	F. A. Peck
San Diego	Dec. 11	Michael's Supper Club, Lemon Grove	6:30	Air Force Quality Audit	D. H. Perry
San Francisco Bay Area	Dec. 12	Ramor Oaks, Atherton	6:30	Management of Quality Assurance	Sam Carrol, Texas Instruments, Inc.
Santa Maria-Vandenberg	Dec. 18	Ricks Rancho, Santa Maria	8:00	.....	.....
Seattle	Dec. 12	.....	7:30	QC Aspects of Restoration of Antique Cars	Stan Colson, Antique Car Club
	Jan. 9	.....	7:30	Experiment Design Aids Engineering Problem Solving	Charles Bicking, The Carborundum Co.
Southern Connecticut	Jan. 10	Bryant Electric Co., Bridgeport	7:30	Gages—Foundations of Accuracy	H. Wunsch, Fonda Gage Co.
Syracuse	Dec. 12	Syracuse Turner's Club	6:30	Communicating Thru Written Reports	H. W. Isleib, Bristol Labs
Toledo	Dec. 8	N.Y.C. Sportsmen's Club	8:00	Christmas Party	.....
	Jan. 4	EST Club Rooms	6:30	Effective Techniques in Presentation of Data to Secure Action	W. A. Shideler, Eaton Mfg. Co.
Toronto	Dec. 12	.....	7:45	Joint Meeting with Society for Non-Destructive Testing	H. J. Jochem
	Jan. 10	C.G.E. Auditorium	7:45	Tool and Gage Control	T. P. Monaghan, Ford Motor Co.
Waco	Dec. 18	Recreation Room, Woodway Fire Station	7:30	Christmas Party	.....
Western Massachusetts	Dec. 12	Sheraton Motor Inn, Springfield	6:30	What Management Needs to Know About Inspection	V. L. Bissonnette, Chapman Valve Mfg. Co.
Winnebago	Dec. 18	Elk's Club, Appleton	5:15	Training Session	.....
			6:30	Dinner Meeting	.....
Worcester	Dec. 14	Kimble Cory	7:00	Air Force Inspection and QC from 1940 to 1960	P. M. Bezanson, U. S. Air Force
Youngstown	Dec. 7	Astoria Cafe, Warren	6:30	Auditing for Quality and Reliability	John Reigle, General Electric
	Dec. 21	Kings Table, Warren	6:30	Christmas Party	.....

WACO . . . The Sept. 18 meeting was held in the Holiday Room of the Holiday Inn Motel. Robert D. Maulden, Williamson Dickie Mfg. Co., Ft. Worth, spoke on "The Responsibilities of QC." His talk followed a 6:15 pm social hour and a 7:00 pm dinner.

A Family Skating Party was held on Sept. 25 at Waco's new Candy Cane Rollercade on Waco Drive. It was attended by 21 persons.

A Christmas party has been planned for the members and their families on Dec. 18 from 7:30 to 10:30 pm in the recreation room of the new Woodway Fire Station.

Jon Tankersley

WASHINGTON . . . The first meeting of the year was held Sept. 27 at the Roger Smith Hotel. Frank Gryna and A. M. Carey, The Martin Co., Baltimore, discussed "Vendor-Vendee Problems in QC and Reliability."

The first executive meeting was held and included discussion in the following areas: membership—the goal of 200 members is well within reach with 110 paid members as of Aug. 31; training chairman Bea Orleans announced plans for a six-lecture program and a 13 lecture program.

The section and EIA is co-sponsoring a symposium on reliability to be held Jan. 9-11. In an effort to help meet the needs of its special groups, Hugh Wilensky, Rixon Electronics, will develop a flyer to be distributed to small business in the area designed to inform prospective members of the new subgroup in the electronics field.

M. Alethia Mayes

WESTERN MASSACHUSETTS . . . The season opened on Sept. 26 with a one day quality assurance seminar designed as a service to companies involved in government contract work who either needed orientation in quality assurance requirements or who have had persistent problems in fulfilling these requirements to government satisfaction. All speakers were from the Boston Ordnance District and included Robert I. Ramsay, Julien A. Desjardins, Thomas Appleton, and Andrew Centauro. Much credit is due "Hy" Edelstein, education committee chairman, for the success of this event.

Victor L. Bissonnette, QC Manager, Chapman Valve Manufacturing Co., will be our speaker for the Dec. 12 meeting to be held at the Sheraton Motor Inn, Springfield. "Vic", a well-known member of this section, is currently serving as chairman of the membership committee. His talk entitled "What Management Needs to Know About Inspection" will be delivered at 8:00 pm with dinner preceding it at 6:30 pm.

Alan J. Donnelly

WINNEBAGO . . . Carl Matson, Gilbert Paper Co., conducted a training session on "QC in the Sheeting of Paper" at our Sept. 18 meeting. Hy Pitt, Statistical Analyst, Oscar Mayer Co., presented a talk entitled "QC and Quality Control."

Andrew F. Blackburn

WORCESTER . . . In spite of Hurricane Esther this section turned out to hear Daniel P. Kelleher, General Electric Co., present his views on "Quality's Position in Management." Our thanks to Mr. Kelleher for his efforts on that very stormy day of Sept. 21.

G. F. Anderson

YOUNGSTOWN . . . John Reigle, QC manager of General Electric's home laundry department, will be the December dinner speaker. His subject will be "Auditing for Quality and Reliability."

The annual Christmas Party will be held on Dec. 21 at the Kings Table Restaurant in Warren. In previous years, "entertaining" home talent was featured.

Eugene Passell

Significant Differences

. . . AKRON-CANTON — **Vincent Gatto,** arrangements chairman, is leaving our section and the employ of the General Tire and Rubber Co. to accept a position with the Gillette Safety Razor Co., Boston, Mass. **James Oesterling,** a past chairman of the Cleveland section, now working for the General Tire and Rubber Co., is our newest member.

. . . ALBANY — **Don Holmes,** L.S.T. & G., General Electric Co., will be our New England Council representative.

. . . ALLENTOWN-BETHLEHEM — **Chuck Basa** has been assigned to the QC Dept., Western Electric. We welcome **Ben Bush,** who is transferring from the Minnesota section, and **Gene Rice,** a new member. Ben and Gene are members of Atlas Chemical Industries' recently augmented QC Team. **Robert Kropp,** Atlas, was promoted from QC technician to production foreman. **Dave Roberts** of Mack Trucks, who was our publicity chairman last year, has accepted the responsibility of publication chairman.

. . . CHATTANOOGA — **Robert Newman,** du Pont, has submitted his resignation from the section as vice-chairman due to the activation of Company B, 844th Engineers Batallion.

. . . CINCINNATI — **Leon Bass,** manager, advanced QC engineering, General Electric, Evendale, went to Israel where he served as a member of a two-man team sent by the International Cooperation Administration, State Dept., to conduct a survey in Israel with respect to QC levels of practice, etc., and to make recommendations regarding quality standards, education, etc. **Dick Race** and **Don Flischel** are instructing courses in QC methods and techniques in the fall educational series of courses.

. . . CLEVELAND — **Dr. Fred C. Leone,** past chairman, was recently appointed associate editor of *Technometrics* in charge of the section "Statistical Progress for High Speed Computers." Dr. Leone, who recently was elected to the Editorial Board of *IQC* has been instrumental in organizing a colloquium series in aspects of computer theory and applied statistics at Case Institute.

. . . CORNING-ELMIRA — **Ed Wintry, Bill Mullen,** and **Fred Cekella** have recently joined the Corning Glass Works QC Staff. **Lew Ashley, Durward Philips, Jack Bostwick** and **Don Fink** of Ingersoll Rand have entered into the confines of our section.

. . . DAYTON — **John E. Condon,** section chairman, has accepted a new position as technical assistant to the chief, QC Staff Office, Headquarters AF Logistics Command, Wright-Patterson. John was formerly head of the reliability and QC section, Military Development Dept., National Cash Register Co.

. . . EVANSVILLE-OWENSBORO — **Ed Stiles** has moved from production planning supervisor of Bucyrus Erie, Evansville, to assistant to the vice president of manufacturing, Underwood Corp., Hartford, Conn.

. . . GREATER MUSKEGON — **Les Shaw,** Gardner-Denver Co., was selected from 1500 men at Fort Eustic, Va. this summer for the "Soldier of the Encampment" award. This honor is a crowning climax to 16 years of Reserve Duty for Les, who stayed on in the Reserves after World War II and who plans to request a discharge this fall. **Howard DeHeen,** formerly of Anderson Boiling Co., Spring Lake, has accepted a tool engineer's position at Hodges Tool and Die Co., Grand Rapids.

. . . HARRISBURG — **Jack Evans,** a former section Saddoris Award chairman, is to be welcomed back from RCA-International to RCA-Lancaster.

. . . HARTFORD—**Phil Ackerman** is now with Pratt & Whitney Aircraft, Inc., as a SQC engineer. **Gene Ellis** conducted a class at the University of Connecticut Graduate School on Statistics.

. . . INDIANAPOLIS — **Theodore W. Meserve,** section secretary, has been promoted by Chrysler Corp. to plant superintendent for second shift operations. **Ralph A. Scherschel,** inter-society relations chairman, is now with Thiokol Chemical Corp. Other new committeemen are: Auditing — chairmen **Francis Bucksot, Orland Sheese** and **Paul Ulmer;** Budget — **J. Chester Long;** Historian — **Henry Kyburz;** Publications — **Mel Handerson;** Subsection Development — **Tom Turner.**

. . . IOWA, STATE UNIVERSITY OF — The section claims distinction in that its membership is scattered throughout 25 cities in the states of Iowa and Illinois. The officers represent 8 different communities.

. . . KANSAS CITY — **Afton Taylor,** Hallmark Cards, formerly a QC supervisor, has been promoted to the Head of the Lithographing Inspection Dept.

At a recent meeting of the Executive Board, it was decided that the section would conduct pre-meeting educational training programs, which will last approximately 45 minutes and will cover the "Tools of QC."

. . . LEXINGTON — The course in physical testing methods was off to a good start with about half of the students from outside the section. A second semester course is being set up to cover electronic testing methods as well as several other interesting areas.

. . . LOS ANGELES — **Henry Matosoff** has left Cannon Electric to accept the position of quality manager at RCA's Van Nuys operation. **Simon Collier,** past president of ASQC, has moved to the Los Angeles area. **R. L. Heath,** section chairman, has invited Mr. Collier to participate in the section activities and lend advice on how to make our society more effective and perform greater service to individual members.

. . . MERRIMACK VALLEY — **Kenneth F. Trott,** section treasurer has joined Carr Fasteners, Cambridge. **George Kay** has joined Sylvania Electric Products Co., Waltham.

. . . METROPOLITAN — **Arthur Bloomberg** has left International Salt Co. and is now employed as a statistician in the QC Dept. of the Rocky Hill plant of the Hercules Powder Co.

. . . MID-HUDSON — **John H. Clovacco** now heads the QC Div., IBM, Poughkeepsie, and **Frank J. Sindelson** has become a member of the IBM QC Corporate Staff.

. . . MINNESOTA — **Ken Rose** recently moved from the Applied Math and Statistics Dept. to the Data Processing Center, Minnesota Mining and Mfg. Co. **Gerald Miller,** formerly with The Toni Co., is now an employee of Minnesota Mining and Mfg. Co. His job is QC engineer in the Gift Wrap and Fabric Div. **Ronald Orinstien,** formerly a Statistician 8, has become professional statistician in Reliability and Audit, Remington Rand Univac. **Eugene Johnson** transferred from the Biostatistics Dept. to the Industrial Engineering Dept. as an Associate Professor at the University of Minnesota.

. . . MONTREAL — **Claude F. Taylor,** Trans-Canada Airlines, has been appointed director of sales management controls. **Roger Lessard,** section education and training program chairman, has been elected first vice-president of the Alumni Association of the University of Montreal. **F. Alex. Gnaedinger,** Canadian Celenese Limited, will serve as the chairman of the Administrative Applications Fourth National Conference which will be held in Montreal on Mar. 29-30. Mr. Gnaedinger, was a guest speaker at the QC Course sponsored by AMA held at Saranac Lake, N.Y. during September.

. . . NEW HAMPSHIRE — **George Lacroix,** formerly assistant to the director of QC, New Hampshire Ball Bearings, Inc., Peterborough, has been named chief inspector of their Laconia Div.

. . . OMAHA-LINCOLN — Twenty-nine individuals representing 14 firms attended the QC short course offered by the Extension Div., University of Nebraska in cooperation with the section. **Professor Niles H. Barnard,** chairman, Dept. of Mechanical Engineering, and **John J. Pappas,** QC engineer, Western Electric, Omaha, both section members, shared the teaching responsibilities.

. . . ORANGE EMPIRE — **Jesse I. Black** addressed the Eighth Annual "Bay Area" QC Conference on Sept. 12 on the subject of "A Statistical Rating System for Synthetic Rubber QC." **Jack E. Jamieson,** formerly with Hughes Ground Systems, Fullerton, is now with Hallamore Electronics, Anaheim. **Charles S. Kleppsattel,** formerly with Hughes Semiconductor, Newport Beach, is now with Autonetics, Anaheim.

. . . ORLANDO-CAPE CANAVERAL — **R. Hostetter,** formerly QC manager, LaCross Project, Martin-Orlando, has returned to the company as Pershing Quality Field Test Manager. **R. H. Nicholson** now has responsibilities as Chief, QC, Atlas Weapons Systems and Atlas Mercury, Agena, and Centaur Space Systems for General Dynamics Corp., Astronautics Div., Atlantic Missile Range operations.

. . . PENSACOLA-MOBILE — **Joseph E. Sanders,** a new member, is now supervisor of the Product QC Section, The Chemstrand Corp. **B. F. Benton,** Senior QC Engineer, Chemstrand, has transferred from the Process QC Section to the Product QC Section. **L. R. Henry,** Senior QC Engineer, Chemstrand, has transferred from the Product QC Section to the Process QC Section.

. . . RACINE — **Joseph Yahnian** became chief inspector, Twin Disc Clutch Co., taking the place of **Frank Giannoni** who retired at the end of July.

. . . SACRAMENTO — Our training committee is preparing the presentation of an inspection work shop tentatively scheduled for early spring. We are losing our program chairman, **Frank Shilosky** who has accepted a new position with Baird Atomic. **Dean Williamson** will take over Frank's role for the balance of the year.

. . . SAN DIEGO — **A. S. Billings,** QC Director, Ryan Aeronautical Co., will retire on Oct. 31 after 21 years of service. **M. P. Kissenger** will become QC Director.

. . . SAN FRANCISCO — **John Yueh,** Lockheed Missiles and Space Co., was promoted to division manager responsible for space systems quality engineering and analysis. Other recent promotions at Lockheed: **Benjamin Churillo** to Research Specialist; **Dan Thompson** to Associate Reliability Engineer; **W. D. Mah-Hing** to Reliability Engineer; **Carl Thoms** to Research Specialist.

. . . SOUTH BEND-MISHAWAKA — **D. L. Correll** has severed his relations with Dodge Mfg. Co., Mishawaka, and has joined the staff of Chrysler Motors, Kokomo.

. . . SOUTHERN ILLINOIS — **Dr. John W. Hamblen** has transferred to our section from the Lexington section. Dr. Hamblen, formerly director of the computing center at the University of Kentucky, is now director of the Southern Illinois University Data Processing and Computing Center.

. . . TENNESSEE — **J. P. Reavis** recently announced the arrival of a daughter, Cynthia. Congratulations, Pat.

. . . WACO — **J. B. McGilvray,** Rocketdyne, McGregor, has been appointed chairman of the section's newly organized telephone committee.

. . . WESTERN MASSACHUSETTS — **Stanley Lezinski,** QC Superintendent, Bigelow-Sanford, Inc., is currently instructing a class in "An Introduction to SQC" presented by this section under the auspices of the Massachusetts University Extension Service. **Hyman Edelstein,** education committee chairman, will instruct a follow-up course for the spring semester entitled, "Introduction to Industrial Experimentation." Classes are being held in the Longmeadow School, Longmeadow.

. . . YOUNGSTOWN — **Paul Belter** has been teaching basic and advanced courses at General Electric this past year.

OUR COVER

It is with some considerable pride that your editors reproduce on the front cover of this issue the Certificate of Merit Award won by the May 1961 issue of *Industrial Quality Control.*

The issue was entered in the Best Single Issue section of the Annual Editorial Competition sponsored by *Industrial Marketing.*

Presentation of the Award was made at the Waldorf Astoria in New York and was accepted by Prof. Mason E. Wescott.

We are, of course, quite proud of the achievement of editorial excellence which this Award reflects, and pledge to continue our efforts for still more improvement in the editorial quality of *Industrial Quality Control.*

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ASQC Announces

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(as of September 30, 1961)

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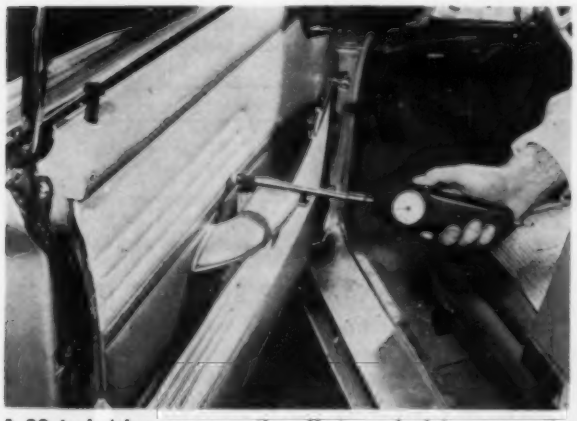
Determining Acceptable Performance Levels For Operation of Car Body Components

To insure customer satisfaction, Ford Motor Company has established strict numerical specifications for operation of body components. The specifications prescribe tests and acceptable performance levels for such assemblies as the glove compartment latches, the door locks, trunk lids and convertible tops.

Rather than merely relying upon the judgement of an inspector, the 33 tests provide quality control inspectors with a numerical measure of the effort required to operate the component. In nearly all of the tests, the variable checked is manual force, such as the push or pull necessary to latch and unlatch and open and close doors, trunk lids, hoods and tailgates. Even the force required to pivot and latch the sun visor is checked against maximum and minimum standards.



A QC technician measures the effort required to engage the door in a check position with a 30-lb. capacity Hunter Force Gage.

Special adapters are used to measure the effort required to operate smaller components.

Operating effort of a few body components cannot be checked by measuring straight-line applied force. For example, the torque needed to turn the key in the door lock is measured with a small torque wrench and the operation of the powered convertible top is checked by measuring the current drawn by its electric power.

Operating effort tests are an important part of the company's stepped up quality control and reliability program which has resulted in significantly lower warranty claims despite extended warranty provisions.

70 Papers, 76 Authors Present New Ideas In 1961 Annual Convention Transactions

If you were unable to attend this year's convention, you won't want to miss the opportunity of obtaining the vast amount of technical information presented. A limited number of copies of the convention transactions are still available from the Headquarters office. Keep your quality control library up-to-date. Order your copy today!

HERE IS A LIST OF THE PAPERS CONTAINED IN THE 1961 CONVENTION TRANSACTIONS

MANAGEMENT

How to Evaluate a Company's Quality Control Need
Quality Cost Control
Quality and Reliability Management
Total Quality Control in Smaller Industries
A Challenge to Labor and Management
Breadth or Depth, Training for Quality Control and Operation Research
Operations Research in Management
Process and Quality Control for Management

PRODUCT APPLICATIONS

Getting Started in Statistical Quality Control
Benefits of Quality Control Inputs in Preparation of Specifications
Why Quality Requirements Must Be Upgraded
Some Recent Developments in Process Control
Statistical Methods for Ceramic Process Control and Experiment Planning
An Introduction to Cumulative Sum Charts

TEXTILE

Variations Flow Analysis for Process Improvement
A Practical Analysis of a Successful SQC Installation in High Quality, High Style Garment Manufacturing
Moisture Control in the Cashmere Industry

QUALITY CONTROL TRAINING

SQC Training for the Chemical Industry

NON-PRODUCT APPLICATIONS

SQC Methods in Telephone Transmission Maintenance
Measuring Relay Contact Erosion
New Departures for Operations Problems
The Human Equation in Quality Control
Bayesian Decision Theory and Statistical Quality Control
Work Sampling

RELIABILITY

Management's Challenge for Product Reliability
How RCA Meets AGREE Test Requirements
Reliability—A Management Problem
Reliability Requirements in Part Specifications
Effective Quality Control Increases Polaris Reliability
Quality Control and Reliability Organization —A Professional Approach
An Adaptation of the MIL-STD-105B Plans to Reliability and Life Testing Applications
Which Road to Satellite Reliability
Reliability Instrument Panel
Myths & Realities in Reliability
Electronics Reliability—A Mechanical Problem
Optimization of Equipment Effectiveness

DATA PROCESSING

Computing Equipment Used for Statistical Studies in the Metals Industry
Mechanized Retrieval of Scientific Information

VENDOR-VENDEE

Do You Make These Quality Control Mistakes in Buyer and Seller Relations?

MILITARY

A Contractor Writes a Military Specification
MCTSA Seeks Quality with Confidence
Signs of our Time Which Forecast Quality
Navy Progress in Quality Control and Reliability in 1960
Qualifications for Military Quality Control Personnel
Slicing the Pie

PRACTICAL APPLICATIONS

What's the Difference?
Practical Application of Normal Probability Paper
Choosing a Sequential Test
Test Performance Charts
Industrial Application of Non-Parametric Statistics
Keep It on the Square
Short Cut Statistical Methods as Applied to Certain Reliability Problems
Hunting and Taming the Wild Observation

RESEARCH AND DEVELOPMENT

Designing Valid Experiments
Response Surface Techniques as a Statistical Approach to Research and Development in Ultrasonic Welding
Quality Control in Research and Development
Controlling Quality in the Production Engineering Climate

SENSORY QUALITY CONTROL

A Quantitative Approach to Classification of Characteristics
Subjective Product Evaluation Methods
Putting the Senses to Work in Quality Control
Statistical Aids to Visual Inspection
Value Analysis and Engineering

INSPECTIONEERING WORKSHOP

Organization of the Inspection Function for Maximum Effectiveness
The Inspection Engineering Approach
A Survey of Visual Inspection
Dial Indicator Service and Cost Control
Dial Gage Maintenance, Repair & Calibration
Cost Control and Quality Control of Dial Indicators
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Advanced Trends in Electric Gaging

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A personnel listing service exists for the use of ASQC members only. Any member desiring to be listed as available for new employment opportunities should send a brief resume (on 3 × 5 file card, or cards) to ASQC Personnel Listing Service, Room 6185 Plankinton Building, 161 West Wisconsin Avenue, Milwaukee 3, Wisconsin.

All information will be kept confidential and those listed will be sent descriptions of all suitable opportunities for 60 days following receipt of this initial listing. If it is your desire to remain on the list after this period, you can do so by writing to the same address and requesting an additional 60 day period. If you do *not* request an extension, your resume will be removed from the file on the assumption that you have made a successful connection.

Companies wishing to post positions available in the ASQC Personnel Listing Service should address all correspondence to the same address as above giving the educational and experience requirements, age and salary limits on each position. The position description should be limited to 100 words plus the complete name and address of the individual to whom resumes should be sent.

AS PARAMETER TOLERANCES BECOME SMALLER THE NEEDS FOR QUALITY CONTROL BECOME MUCH GREATER!

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To aid systems designers in the selection of parts for maximum reliability assurance; review circuits in advanced aerospace systems for adequacy of part characteristics with respect to electrical, mechanical, and environmental loads; generate approved parts lis*; and formulate test and procurement specifications. BSEE required and minimum of 3 years' experience associated with electronic parts applications including semi-conductor devices.

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(as of August 18, 1961)

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JANUARY

. . . 9—Short Course in QC, Jan. 9-Apr. 3, University of Nebraska Medical Campus, Omaha, Nebr., sponsored by the Omaha-Lincoln Section, ASQC, and the Extension Division, University of Nebraska. Contact Niles H. Barnard, 203 Richards Hall, University of Nebraska, Lincoln 8, Nebraska.

. . . 9-11—Eighth National Symposium on Reliability and QC, Statler-Hilton Hotel, Washington, D.C., sponsored by ASQC, IRE, EIA and AIEE. Contact A. R. Park, Mail Stop 729, Westinghouse Electric Corp., P.O. Box 1897, Baltimore 3, Maryland.

. . . 23-27—Third Annual ERA Convention and Management Conference, Hollywood Beach Hotel, Hollywood Beach, Fla., sponsored by Electronic Representatives Association.

. . . 24-26—ASME Second Symposium on Thermophysical Properties, Princeton University, Princeton, N. J., sponsored by American Society of Mechanical Engineers.

. . . 25-27 — Seventh Workshop-Seminar on Management of QC, Sheraton-Blackstone Hotel, Chicago, Ill., sponsored by ASQC, course fee is $125 for non-members and $100 for ASQC members. Contact Seventh ASQC Workshop-Seminar, ASQC Institute, 161 West Wisconsin Ave., Milwaukee 3, Wis.

. . . 27—Eleventh Annual All Day Conference, Sinton Hotel, Cincinnati, Ohio, sponsored by Cincinnati Section, ASQC. Contact Don Fleischel, 2286 Deblin Drive, Cincinnati 32, Ohio.

. . . 27—Sixth Annual Inland Empire QC Conference, California State Polytechnic College, Kellogg Campus, Pomona, Calif. Contact S. Roy Wood, 1305 S. Rimsdale Drive, West Covina, Calif.

. . . 29-Feb. 2—AIEE Electrical Engineering Exposition, New York Coliseum, New York City, sponsored by American Institute of Electrical Engineers. Contact Reber-Friel Co., 117 S. 17th St., Philadelphia 3, Pa.

. . . 29-Feb. 2—Measurement Short Courses, Arizona State University, Tempe, Ariz. ($200 fee for lecture program and $125 fee for experimental program). Contact Prof. Peter K. Stein, Engineering Center, Arizona State University, Tempe, Ariz.

. . . 30-Feb. 2—Eighteenth Annual Technical Conference, Society of Plastics Engineers, Penn-Sheraton Hotel, Pittsburgh, Pa. Contact SPE, 65 Prospect Street, Stamford, Conn.

FEBRUARY

. . . 7-9—National Winter Convention on Military Electronics, Ambassador Hotel, Los An-

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geles, Calif., sponsored by IRE. Contact Matthew E. Brady, Technical Program Committee, Institute of Radio Engineers, 1 East 79th St., New York 21, N.Y.

. . . **8-10—Three-day course on the Evaluation and Interpretation of Physical and Chemical Testing Methods, Downtowner Motor Inn, Kingsport, Tenn., co-sponsored by the Chemical Division, ASQC and the Northeast Tennessee Section, ASQC. Contact Stanley A. Murray, Tennessee Eastman Co., Kingsport, Tenn.**

. . . **15-16—Twelfth Annual Conference, Clemson House, Clemson College, Clemson, S. C., sponsored by the Textile and Needle Trades Division, ASQC. Contact W. S. McMann, Dan River Mills, Inc., Danville, Va.**

. . . **18-22**—47th Annual Meeting, Technical Association of the Pulp and Paper Industry, Commodore Hotel, New York City. Contact TAPPI, 360 Lexington Ave., New York 17, N.Y.

. . . **26-Mar. 2**—QC Course, American Management Association Academy, Saranac Lake, N.Y. Contact AMA Registrar, 1515 Broadway, New York 36, N.Y.

MARCH

. . . **5-9**—Thirteenth Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Penn-Sheraton Hotel, Pittsburgh, Pa., sponsored by the Analytical Chemistry Group of the Pittsburgh Section, ACS and the Spectroscopy Society of Pittsburgh. Contact Dr. C. F. Glick, Applied Research Laboratory, U.S. Steel Corp., Monroeville, Pa.

. . . **8-9—Middle Atlantic Conference, ASQC, Statler-Hilton Hotel, Washington, D.C. Contact Gilbert L. Maton, John I. Thompson & Co., 1118 22nd St., N.W., Washington 7, D.C.**

. . . **17—Annual QC Seminar, sponsored by the Southern Connecticut Section, ASQC, in conjunction with the University of Bridgeport, Bridgeport, Conn. Contact Theodore H. Reuther, Bryant Electric Co., Box D, Barnum Station, Bridgeport, Conn.**

. . . **24—Annual Forum, University Center, Western Michigan University, Kalamazoo, Mich., sponsored by Battle Creek-Kalamazoo section, ASQC. Contact Dr. Andrew C. Luff, 3504 Canterbury Road, Kalamazoo, Mich.**

. . . **24—Seventh Annual QC Symposium, Dan Rogers Hall, Texas Christian University, sponsored by the Dallas-Fort Worth Section, ASQC. Contact Mark R. Seldon, 810 Cedar Hill, Dallas, Texas.**

. . . **27—Rochester QC Conference, University of Rochester, Rochester, N.Y., sponsored by the Rochester Section, ASQC. Contact Wilbur C. Myers, Delco Appliance Division, GMC, 391 Lyell Ave., Rochester, N.Y.**

. . . **29-30—Conference, Administrative Applications Division, ASQC, Ecole Polytechnique, University of Montreal, Montreal, Quebec. Contact J. B. Pringle, Bell Telephone Company of Canada, 1050 Beaver Hall Hill, Montreal 1. Que.**

APRIL

. . . **4-6—Eighth ASQC Workshop-Seminar on Management of QC, Hotel Roosevelt, Los Angeles, Calif., sponsored by ASQC, course fee is $125 for non-members and $100 for ASQC members. Contact Eighth ASQC Workshop-Seminar, ASQC Institute, 161 West Wisconsin Ave., Milwaukee 3, Wis.**

. . . **8—Thirteenth Annual Advanced SQC Institute, University of Connecticut, Storrs, Conn., co-sponsored by the New England sections of ASQC and the School of Business Administration. Contact R. M. Story, Jr., University of Connecticut, Storrs, Conn.**

. . . **11-13**—Technical Meeting and Equipment Exposition of the Institute of Environmental Sciences, Sheraton Hotel, Chicago, Ill. Contact H. F. Sander, Executive Secretary, P.O. Box 191, Mt. Prospect, Ill.

. . . **14—Second Annual Forum, Toledo Section, ASQC, Hillcrest Hotel, Toledo, Ohio. Contact T. R. Meyer, Owens-Illinois Glass Co., Box 1035, Toledo 1, Ohio.**

. . . **18—The Complex of a Program Quality Control System, Stanley Club, Pittsfield, Mass., sponsored by Pittsfield section, ASQC. Contact J. L. Roberts, Jr., Ordnance Dept., General Electric Co., 100 Plastics Ave., Pittsfield, Mass.**

. . . **27-28—SQC Conference, Hotel Anthes, Fort Madison, Iowa, sponsored by the State University of Iowa Section, ASQC. Contact G. J. Narigon, Iowa State Industries, Box 316, Fort Madison, Iowa.**

MAY

. . . **8-10**—Twelfth Annual Electronics Components Conference, Washington, D. C., co-sponsored by AIEE, EIA and IRE with participation by ASQC and SNT.

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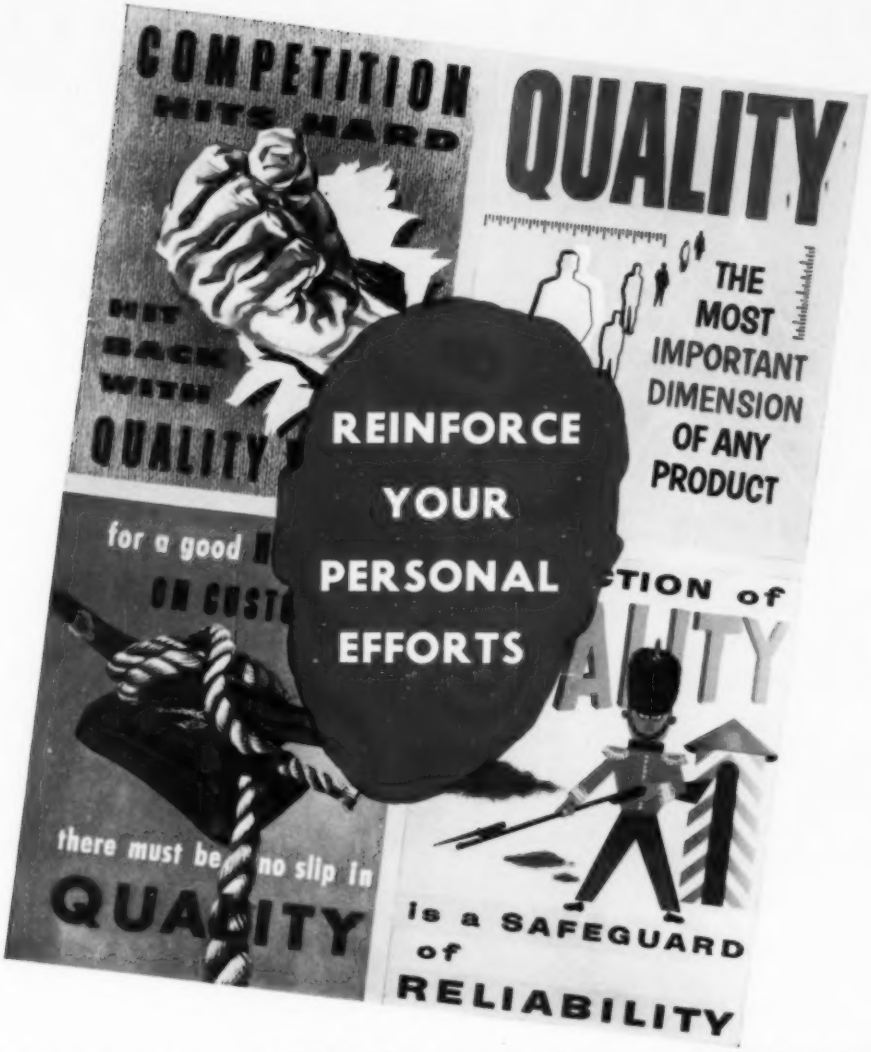

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The new Nikon model 3A permits surface as well as contour inspection—independently or simultaneously. And controls are provided for adjusting the intensity of each of the illuminators.

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Model 3A is normally supplied with a choice of one or more standard lenses in magnifications ranging from 10x to 100x. Other magnifications are also available on special order. A 3-lens turret supplied as standard equipment, facilitates instant changes. Focusing is smooth and effortless. Utilizes leadscrew drive with scraped ways and adjustable gibs.

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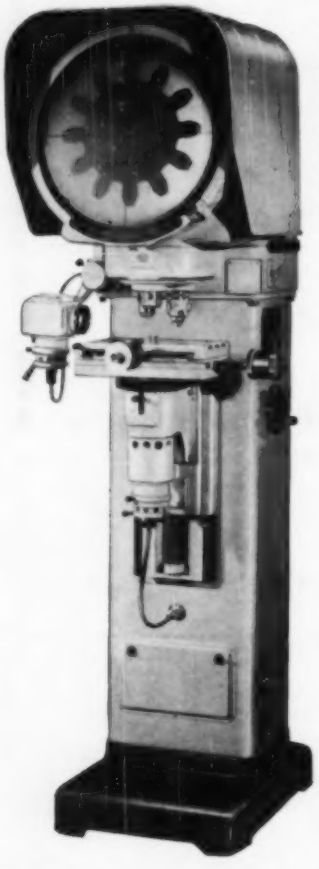

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